Vol. 12, No. 3 May-June, 1956

LUBRICATION ENGINEERING

RESEARCH APPLICATION EDUCATION MAINTENANCE

In This Issue

Evaluation Of Crankcase Lubricants For Radial Gas Engines
by D.W. Sawyer, H. D. Keefer, E. M. Kipp & R. W. Shaw 183

Spray & Drip Methods Of Applying Lubricant To Wire Rope, The
by D. B. Burroughs 193

Disposal Of Soluble Oil Wastes, The
by E. E. McClung 196

Tapping Test For Evaluating Cutting Fluids, A
by C. D. Flemming & L. H. Sudholz 199

Advertisers' Index 224
ASLE Directory 205
ASLE News Notebook (includes Annual Meeting Hi-Lites) 177
ASLE Officers & Directors for 1956-57 204
Book Reviews 220
Coming Events 203
Engineering Societies Personnel Service, Inc. 223
Experiment & Experience (1) "Effect of Atmospheric Moisture & Oxygen Content on High-Temperature Lubrication of Ball Bearings with Graphite," by Z. N. Nemeth & W. J. Anderson, and (2) "Lubrication Practices in a Steel Mill," by J. H. Frier 169
In Memorium: L. W. Deutsch 195
Letters to the Editor (Commentary by J. T. Burwell, Jr. & F. C. Wagner on: "Effects of Sliding Velocity & Temperature on Wear & Friction of Several Materials," by R. L. Johnson, M. A. Swikert & E. E. Bisson; and Authors' Closure) 165
Lube Lines, by A. F. Brewer 173
Lubrication Abstracts, compiled by Henry Brutcher 211
Lubrication in the News 166
New Products 213
Personals 203
Reorganization of ASLE Committee Structure 206
Section News 192

JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

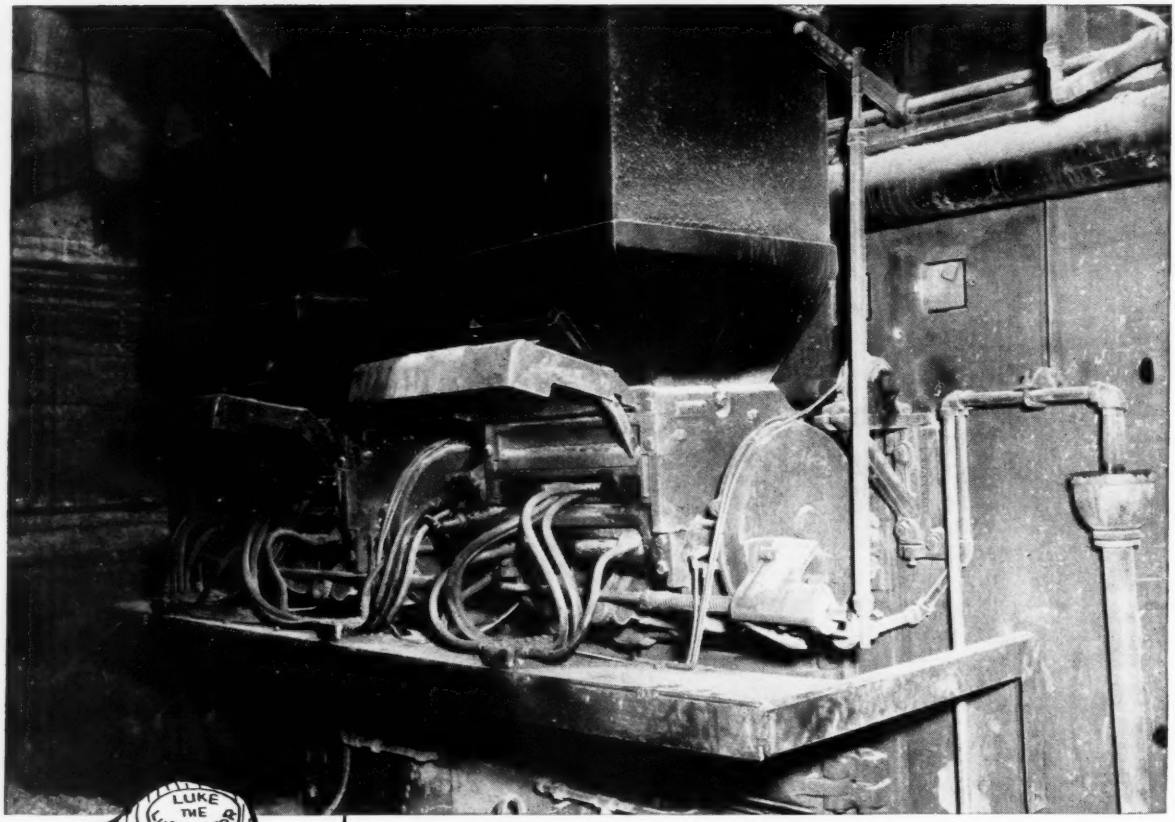

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Table Of Contents

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by E. E. McClung 196

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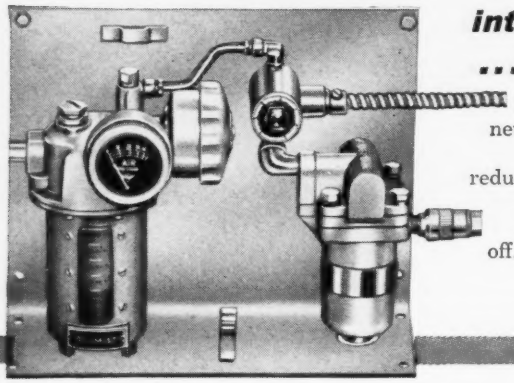

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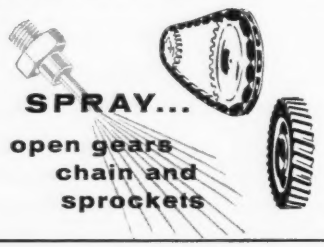

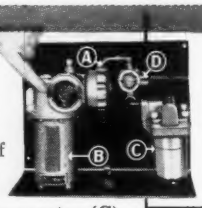

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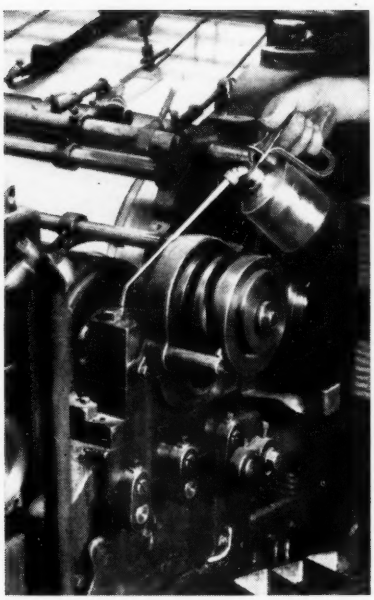

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Letters to the Editor

COMMENTARY by J. T. Burwell, Jr. & F. C. Wagner, Horizons, Inc., Cleveland, Ohio, on "Effects of Sliding Velocity & Temperature on Wear & Friction of Several Materials" by R. L. Johnson, M. A. Swikert & E. E. Bisson (**Lubrication Engineering**, May-June, 1955, pp. 164-170).

Messrs. Johnson, Swikert, and Bisson are to be complimented on the work they have done toward attempting to solve the very important problem of finding better material for the cages or retainers of rolling contact bearings for the newer aircraft gas turbine engines. They have principally investigated leaded brass, iron-silicon bronze, cast Inconel, and several nodular irons at sliding speeds of 18,000 ft. per minute at room temperature, or at 8000 ft. per minute at temperatures up to 600 F., and at 120 ft. per minute at temperatures up to 1000 F. They have found cast Inconel and the nodular iron, especially when the Inconel is pre-treated, to give significantly better performance than either of the bronzes or H Monel.

Under contract AF-33(616)2099 with the Wright Air Development Center, the writers have likewise been attempting to discover improved retainer materials for this same application. Since our operating conditions were somewhat different, and we found somewhat different relative performance for these types of material, it seems worthwhile to briefly mention some of our results for the purposes of comparison.

To begin with, our test machine undertook to simulate fairly exactly the conditions of rubbing speed, load, ambient temperature, and geometry encountered in an actual roller bearing by reconstructing a section of the inner race locating surface and cage of a 200 mm. bearing class size. These conditions were as follows: speed, 26,400 ft. per minute; load, variable up to 23 lbs. on the specimen; ambient temperature, up to 750 F.; oil inlet temperature, 200 F.; oil flow, variable from 0.5 to 3.0 gal/min.

Geometry of the test machine and specimen are shown schematically in Fig. 1. They were enclosed in a thermally-insulated box, and provision made for heating both the rotor and the specimen. Lubrication was by two jets directed against the interface on opposite sides. The temperature of the retainer material specimen was measured by a thermocouple located approximately 1/32" back of the rubbing surface and under the load line. Initially, an SAE 52100 alloy steel was used for the rotor, but as this showed signs of deterioration at the higher temperatures, these runs were made with a high-speed tool steel (AISI Type T-1).

The poorer materials were found to be characterized by high friction, scoring of the rotor, and pickup of the specimen material on the rotor, leading in relatively short time to an extreme vibratory condition. Generally in these instances it was not possible to measure a well-defined wear rate, but it was obvious from the scoring and metal transfer to the rotor that the performance of the material would not be satisfactory under these conditions. Materials in this class were nodular iron, Ni-resist cast iron, and wrought Inconel.

Somewhat more satisfactory were iron-silicon bronze, S Monel, and cast Inconel, where a well-defined wear rate could be measured at various temperatures. These wear rates as a function of temperature are shown in Fig. 2. A lead bronze that was tested was found to pick up on the rotor to a somewhat greater degree than the iron-silicon bronze.

Still more satisfactory, with respect to a lower wear rate and less pickup on the rotor than either the iron-silicon bronze or the S-Monel, was found to be a class of complex silver-infiltered nickel alloys prepared by powder metallurgy techniques. The wear rate of one such material is also shown in Fig. 2 for comparison.

Since the conditions of our high-temperature tests were considerably more severe than those of Bisson, et al., close comparison of results is difficult. However, it is of interest to attempt to compare the dependence of wear rate on temperature in the two cases. For example, in the NACA tests, iron-silicon bronze wear rates showed a continual but slight increase up to 800 F.; at higher temperatures (800 to 1000 F.) wear increased more rapidly. Under the conditions of our test this rapid increase in wear rate set in at about 250-300 F., a significant difference.

In some recent work (T. Sata, Proc. 3rd Jap. Nat. Congr. App. Mech., p. 153), Sata has shown that there is a critical true surface temperature for the onset of rapid wear with any given material. Since this surface temperature is composed of contributions from both the ambient temperature and the friction-generated heat, then at heavier loads and higher speeds the ambient temperature to produce a corresponding amount of wear will be expected to be lower. Since Bisson, et al., are probably measuring in the main an ambient rather than a true surface temperature with their bayonet thermocouple (and, by the same token, their calibration of this thermocouple against one installed in the rider specimen may be similarly affected by load and speed), it might be expected that with their significantly slower speeds they would measure a higher ambient temperature for the corresponding wear rate.

The complete results of our work will be published in the near future.

(See next page for Johnson-Swikert-Bisson Closure.)

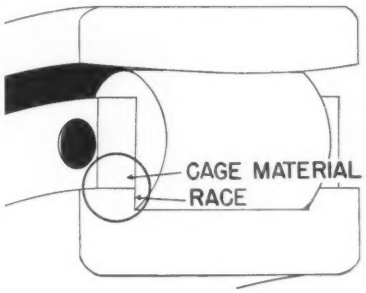


Fig. 1. Representation of section of bearing used for simulated service wear tests.

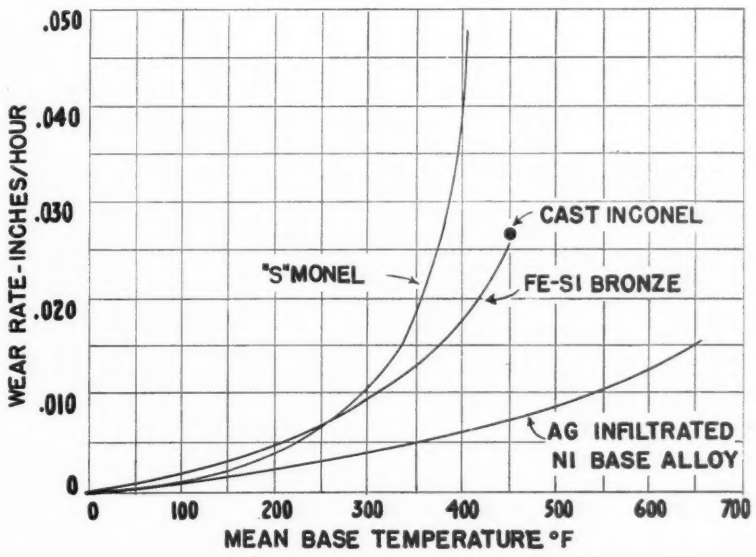


Fig. 2. Comparison of standard materials to newly-developed materials with respect to wear rates as a function of temperature.

(Letters, Continued from p. 165)

CLOSURE by R. L. Johnson, M. A. Swikert & E. E. Bisson. The supplemental information provided by Burwell and Wagner is very much appreciated. The differences in operating conditions could well account for the variance in results.

The matter of selecting the proper operating conditions to simulate bearing operation is very difficult. Roller skewing, misalignment, thermal distortion, and other factors make it difficult to establish a realistic load level for cage materials. In some cases, loads sufficient to cause plastic flow of bronze materials have occurred in cage pockets of aircraft turbine bearings operated under apparently normal conditions.

The availability of lubricant and the temperature of the lubricant are other important factors. The extreme condition that can occur and which probably leads to many failures, is where no lubrication is present, as on starting the engine or during oil flow interruption. The conditions of lubricant supply used by Burwell and Wagner are about as favorable as might be expected in a bearing. In the NACA research, the opposite approach has been taken where there is either no lubrication or with lubrication under unfavorable conditions.

It should be mentioned that the steels used in the two investigations were different. It is also difficult to compare the cage materials common to both investigations. Nodular iron, for instance, is a designation covering an extreme variety of materials. Even with the same nominal compositions, considerable differences in structure of nodular iron can occur. The distribution and size of nodules could be important. Also, nodular irons show a tendency to have free ferrite surrounding the graphitic nodules. The adverse effect of free ferrite for slider surfaces is, of course, well known. The structures of several NACA materials are shown in Fig. 1 of this closure. They were used in the "as cast" condition, but it is known that heat treatment can have a considerable affect on their wear and surface failure properties.

Unreported NACA data also indicates that nodular Xi-resist has somewhat better wear resistance than a regular Xi-resist cast iron. Burwell and Wagner report that cast Inconel had better resistance to wear and scoring than wrought Inconel. NACA data has shown that cast materials of this and similar types are generally better than wrought materials. Another case of interest may be that of iron-silicon-bronze. Different batches of materials of the same commercial source and designation were very much different in wear and surface failure properties. A batch with very coarse structure (used in obtaining the data reported) had better wear resistance than a more homogeneous fine grained material.

We agree that interface temperature is a primary factor in the friction, wear, and surface failure properties of sliding materials. Considerable friction and wear data with various materials and conditions of lubrication, indicate that either increasing sliding velocity or increasing temperatures may have similar effects. This is consistent with the viewpoint of Sata. The bayonet thermocouple was used in only the low sliding velocity experiments. In other cases the thermocouple was installed in the rider specimen $^{3}/_{16}$ inch from the tip of the hemisphere. It is not suggested that this location gives a measure of surface temperatures; however, neither does a thermocouple located $^{1}/_{32}$ incl. from the surface.

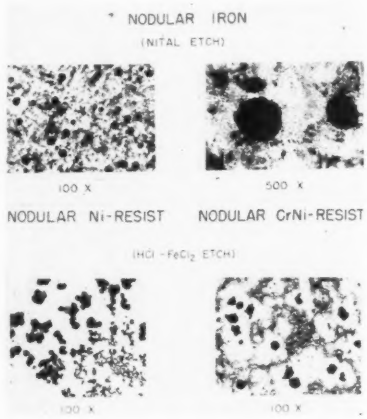
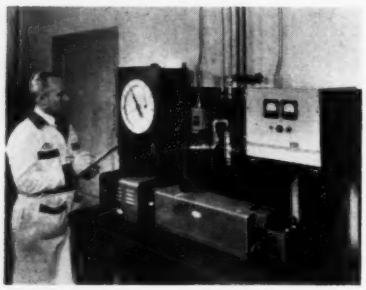


Fig. 1. Photomicrographs of various nodular iron cage materials.

Lubrication in the News



Science Laboratory Instrument Insures Accuracy on Factory Production. A complex, scientific laboratory instrument on a production line of The AP Parts Corporation (Toledo, Ohio) industrial plant helps produce an engine oil supplement with a degree of purity and quality control never before possible. A spectrophotometer (pictured above), normally employed only for precision science laboratory work, is used on the production line to check every 500-gallon batch of Miracle Power, a colloidal synthetic graphited lubricant.

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Special adaptation had to be made by engineers before the laboratory equipment could be used for a continual check of a production line product. Frequently, time-consuming laboratory tests are also run of duplicate samples, to make sure the spectrophotometer is working properly.

M.I.T. Offers Summer Short-Term Course. Massachusetts Institute of Technology offers a special summer program in "Wear Theory in Metal Cutting & Bearing Design," June 18-29, 1956, designed for research workers, teachers, development engineers, and others concerned with the general problem of preventing wear between surfaces that operate in sliding and cutting contact. The several types of wear that normally contribute to the gradual deterioration of surfaces will be considered, and new developments in the theories that have been devised to explain the several types of wear will be discussed. The morning sessions will be devoted to lectures of a fundamental nature presented by members of the staff and selected guest lecturers; afternoons will be spent in the laboratories of the Metals Processing Division of the Mechanical Engineering Depart-

(Continued on p. 221)

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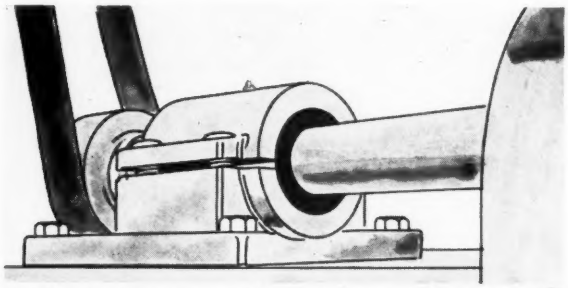

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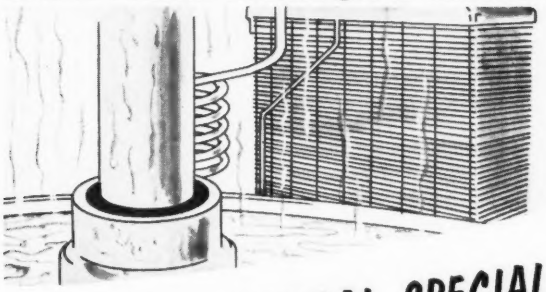

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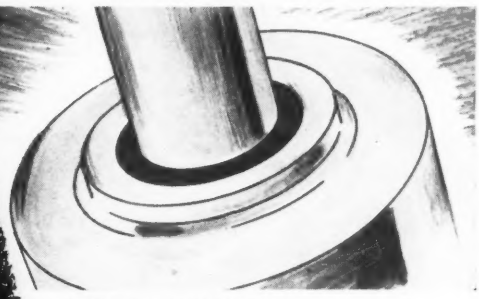

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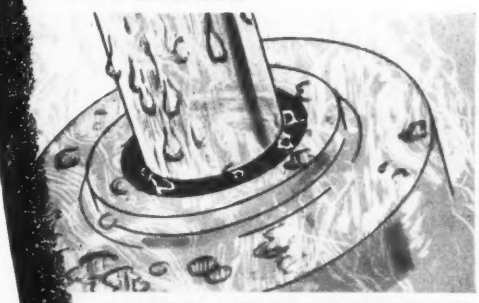

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For more than 80 years, Houghton has specialized in blending, compounding and improving refinery products. This has resulted in a complete line of specialty lubricants for temperatures up to 1000°F and down to minus 65°F—high film strength lubes for heavy duty service and for 10,000 rpm spindle bearings—and greases that stay put, that won't melt, that resist change.

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Effect Of Atmospheric Moisture & Oxygen Content On High-Temperature Lubrication Of Ball Bearings With Graphite, by Z. N. Nemeth & W. J. Anderson (NACA, Lewis Flight Propulsion Laboratory, 21000 Brookpark Rd., Cleveland 11, Ohio).

In previous tests[1] it was found that graphite in a carrier of moist air was an effective lubricant for 20 millimeter bore 18-4-1 tool steel ball bearings at temperatures from 100 to 1000 F., and that dry graphite in dry air was not as effective at 700 and 850 F. as was the graphite in moist air. At 1000 F., however, the dry graphite in dry air and the graphite in moist air were equally effective. In these tests the bearings, which were equipped with two-piece stamped and riveted silver-plated beryllium copper cages, were run at 2500 rpm and 110 pounds thrust load.

Studies by other investigators had led to the belief that adsorption of water was required for graphite to exhibit lubricating properties. No explanation was available as to why the dry graphite provided satisfactory bearing lubrication in dry air at 1000 F. However, it was believed that perhaps oxygen was involved in some way. Therefore, it was thought that similar experiments using nitrogen as the carrier for graphite might possibly shed some light on this point.

Recent experiments have shown that, under the conditions of these tests, graphite will not lubricate at 1000 F. for more than 5 hours, on the average, with dry prepurified nitrogen as the carrier. With the addition of water vapor to the nitrogen, the bearing ran for 20 hours at 1000 F. without failure. A brief summary of these tests is shown in Table I. At first glance these results seem at odds with the results obtained with air where the presence of moisture was not critical at 1000 F.

From these experiments it is apparent that the presence of either oxygen or water vapor is sufficient for graphite to lubricate. Graphite would not lubricate when neither was present, for example, when the bearing was run in dry prepurified nitrogen. The mechanism of graphite lubrication in an atmosphere partially composed of oxygen is postulated in Ref. 2. They found that the graphite powder lubricated satisfactorily at temperatures sufficiently high to promote oxidation of the metal surfaces. The increasing effectiveness of the dry graphite in dry air with increasing temperature from 700 to 1000 F. (Table I, test 2) seems to support this finding. Friction torque decreased from 0.42 in. lbs. at 700 F. to 0.09 in. lbs. at 1000 F. It is also stated in Ref. 2 that control of humidity is not critical in tests at high temperature in an atmosphere containing oxygen.

Table I. Test Results. Key: (a) Ref. 1; (b) Lubricant flow rate was 0.00002 to 0.00015 lb/min.

Test No.	Lubricant[b]	Atmosphere	Average bearing torque, in-lb		Remarks
			700 F.	1000 F.	
1[a]	Synthetic graphite	Air	0.06	0.08	Completed two hrs. at 1000 F. Bearing very clean and free. Negligible wear. Total running time, 18.65 hrs. test run at 100 to 1000 F.
2[a]	Dry synthetic graphite	Dry air	0.42	0.09	Completed two hrs. at 1000 F. Bearing clean and free. Total running time, 18.5 hrs. Test run at 100 to 1000 F.
3[a]	Synthetic graphite	Air		0.03 to .13	Completed 20 hrs. at 1000 F. Bearing in good condition and free. Test run at 1000 F.
4	Synthetic graphite	Prepurified nitrogen		0.44 (1.75 at failure)	Bearing failed after 5.25 hrs., cage not broken, however. Friction torque high after failure. Test run at 1000 F.
5	Synthetic graphite	Moist prepurified nitrogen		0.28 to .38	Completed 20 hrs. at 1000 F. Bearing clean and free. Test run at 1000 F.

BIBLIOGRAPHY

(1) Z. N. Nemeth & W. J. Anderson: Effect of Air & Nitrogen Atmospheres on the Temperature Limitations of Liquid & Solid Lubricants in Ball Bearings. Lubrication Engineering, Vol. 11, No. 4, July-August, 1955, pp. 267-272.

(2) M. B. Peterson & R. L. Johnson: Friction Studies of Graphite & Mixtures of Graphite with Several Metallic Oxides & Salts at Temperatures to 1000 F. NACA, TN 3657, 1955.

Lubrication Practices In A Steel Mill, by J. H. Frier (Kaiser Steel Corp., P. O. Box 217, Fontana, California).

Observations made in several steel mills indicate that lubrication practices as applied at the Fontana Plant are in many aspects quite similar to those of the average steel plant, with a few exceptions.

The Kaiser Plant has many and varied types of automatic grease and oil lubricating systems. However, the general idea of all automatic grease systems is based on a similar principle with the following differences. Some companies use a dual-line system, whereas others employ a single-line or progressive-type system. Both methods are effective when used in the right application, but either method chosen must be given constant preventive maintenance if constant results are to be expected. If the equipment they serve merits maintenance, then negligence of the lubrication system will result in unsatisfactory performance. The use of

(Continued on next page)

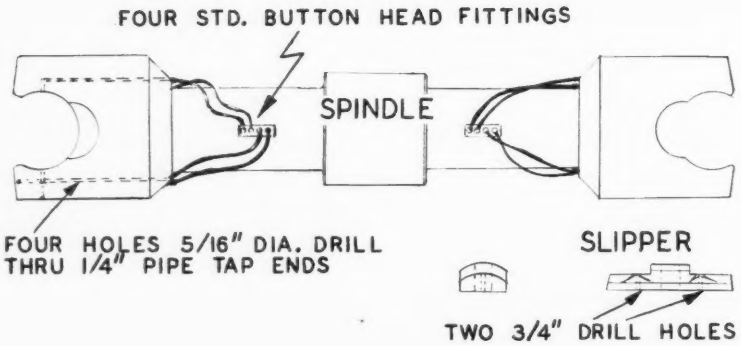
(Experiment, Continued from p. 169)

automatic grease systems has definitely eliminated a good percentage of the hazards involved in lubricating steel mill equipment or any other type of heavy-duty machinery. Conversely, it has also added considerable responsibility upon the mechanical maintenance personnel involved. In the lubrication of gears and bearings in mill equipment, the use of automatic circulating-oil systems has been a step forward. However, constant alertness for broken or leaking lines or gaskets, and damaged or worn seals, must be maintained or very excessive losses of oil can and do occur. Water and other contaminants are constantly a source of trouble. To combat this, filters have been added or installed to remove excess scale and other contaminants.

The centrifuge has been installed to take care of the excess water and many types of solids. Of course, it must be remembered that the centrifuge, like other equipment, requires constant maintenance, such as cleaning and proper adjustment of temperature controls for satisfactory water separation. The oil must be held at a constant temperature of 160 F. min., 200 F. max.

We, at Fontana, have developed a more modern and practical application to the problem of lubricating lineshaft and table roll miter gears. This consists of a spray-type system under pressure atomized by air. The lubricant is of a residual-type product cut back with a very volatile non-flammable thinner, and the system has proven to be very economical and provides more positive lubrication in many locations where leakage on mill tables and seals are so constant. This type of lubricant is highly water-resistant, and adheres to the metal when sprayed. Since application of lubricant is required only once in eight hours, good maintenance of the lubrication equipment is imperative. A pump failure on plugged lines would be disastrous.

We also have a number of oil-mist units operating in this plant. I am of the opinion that this is one of the modern-type positive methods of lubrication



from an economical and maintenance standpoint. Of course, none of the equipment mentioned above is self-maintained; neither will they cure all lubrication problems.

With the many types of automatic oil and grease systems, it is very noticeable that the personnel assigned as an oiler often takes the easy way out and endeavors to lag in his responsibility and maintenance of such equipment. For a better guide to the oiler or to the man doing the lubrication work, we have designed a lubrication chart showing the component parts of each piece of equipment requiring lubrication, the type of lubrication required, and the interval of application.

In order that we may better maintain lubrication equipment, it has become necessary to assign the responsibility for lubrication failures to the oiler on shift, if the cause is a lack of lubricant. The oiler is held responsible for the operating condition of all oil and grease equipment operating on his assigned turn. In the event of equipment failure, it again becomes the responsibility of the oiler to see that the lubrication is provided manually, until such time as the equipment is repaired and put back into operation. This has proven to be a great help to the oiler as well as to the mechanical maintenance departments.

The selection of lubricants is a very important part in this program. The setting up of lubrication specifications at our plant is of real importance for two reasons: (1) to give the purchasing department a guide to the lubricant requirements, and (2) to require all suppliers to bid on a standard or high quality of merchandise. Many times the purchasing department is confronted with some specialty house having a new product that will solve our lubrication problems, ranging in price from 60c a pound to $6.00 a gallon. These products, however, do have a definite place in the lubrication field for some type of equipment where consumption is far less than that of any steel mill.

One of the problems in lubrication of steel mill equipment is the lubrication of spindle slippers. Most everyone in the Industry has given this some serious thought, and many very practical methods have been developed over the years. Some are using oil sprays on the slippers constantly. This is a very effective method, but presents a very serious fire hazard. We, at Fontana, have recently developed a new idea for the lubrication of spindle slippers which has proven to be very satisfactory. The first and most important part of this application is to be sure that the lubricant applied reaches the wearing surfaces in sufficient quantities to perform the desired effect. The lubricant must have sufficient adhesiveness as well as a cohesive quality to resist being removed by centrifical force. The method of application in the Fontana plant is accomplished by drilling through the length of the spindle head with a 5/16" dia. drill from the shaft shoulder to the front or face of the spindle head, at the top half and lower half on both sides, and then drill into the spindle at the top and bottom edge of the shoulder or

(Continued on p. 208)

ADC* REPORT

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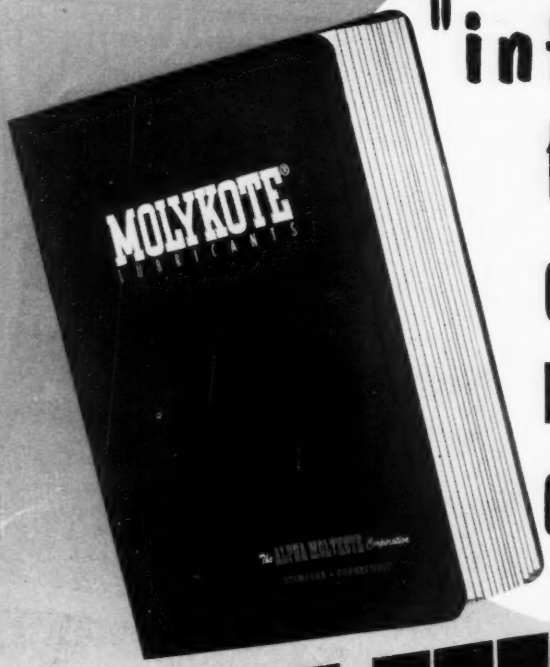

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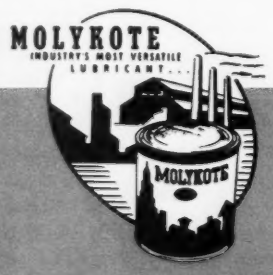

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Lube Lines

by A. F. Brewer*

RELATION OF DESIGN TO LUBRICATION. The production value of machinery is of vital interest to management. Unless there is adequate return on the investment to cover the dividend requirements, amortization, and the operating and maintenance costs, any piece of production or power plant machinery is not paying off. Operating and maintenance costs are related to design and lubrication. In fact, modern machinery is designed not only for production, but it also must be designed for lubrication.

Today, therefore, lubrication begins on the drafting board. The designing engineer considers the prospective operating conditions, the probability of over-load beyond specified limits, the practicability of using centralized lubrication, the requirements for precision mechanisms, and the necessity for developing a finished machine which is an adjunct to personal safety. Any machine which must be lubricated manually where intricate parts are involved is a potential hazard. Regardless of instructions for shut-down for lubrication, the tendency to "take a chance" prevails. It can contribute to poor safety records.

Speed, a Factor. Speed is probably the most important operating condition which concerns the designing engineer. Throughout industry, machinery has been speeded up to meet production requirements. Over a period of barely ten years, strip steel rolling has been stepped up from a few hundred to several thousand feet a minute. Mile-a-minute rolling is said to be quite practicable. Finished paper runs off the paper machine at speeds approaching two thousand feet a minute. Textile spindles in the cotton mill turn at from nine to eleven thousand rpm, according to the type of bearing. Precision grinding of metals is most successfully attained when very high spindle speed is developed. In internal grinding as practiced in the ball and roller bearing industry, spindle speeds as high as sixty-five thousand rpm are employed to produce the desired precise cutting effect of the grinding wheel.

In order to be sure that these speeds can be maintained successfully and continually by the assembly of bearings and gears involved, bearing, shaft, and gear tooth surfaces must be precisely finished. Lower tolerances are a factor in obtaining the required alignment. These low tolerances, termed clearances in plain bearing service, assure that the mechanisms can be run at higher speeds and that increased load can be carried more dependably, especially where the film strength of the lubricant is improved by extreme-pressure additives, and stability is promoted by oxidation and rust retarding additives.

(Continued on p. 222)

*Consultant, and Author of "Basic Lubrication Practice."

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A limited supply of the following preprints of papers presented at the ASLE 11th Annual Meeting, Pittsburgh, April 4-5-6, 1956, are currently available at 35c each to members, 50c each to non-members. Indicate number of copies desired, fill in your name and address, enclose remittance, and mail to:

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_____(AM3A-1) **Grease Flow in Shielded Bearings,** by R. O'Halloran, J. J. Kolfenbach & H. L. Leland
_____(AM3C-3) **Investigation of Oil Additives for Boundary Lubrication of Railroad Journal Bearings,** by A. Miller & A. A. Anderson
_____(AM2C-1) **Lubrication Engineer Surveys Steel Mill Gearing, A,** by A. E. Cichelli
_____(AM2C-3) **Lubrication in the Presence of Nuclear Radiation,** by R. O. Bolt & J. G. Carroll
_____(AM5A-1) **Lubrication of Aircraft Oscillating Control Bearings at High Temperatures,** by D. C. McGahey & R. S. Barnett
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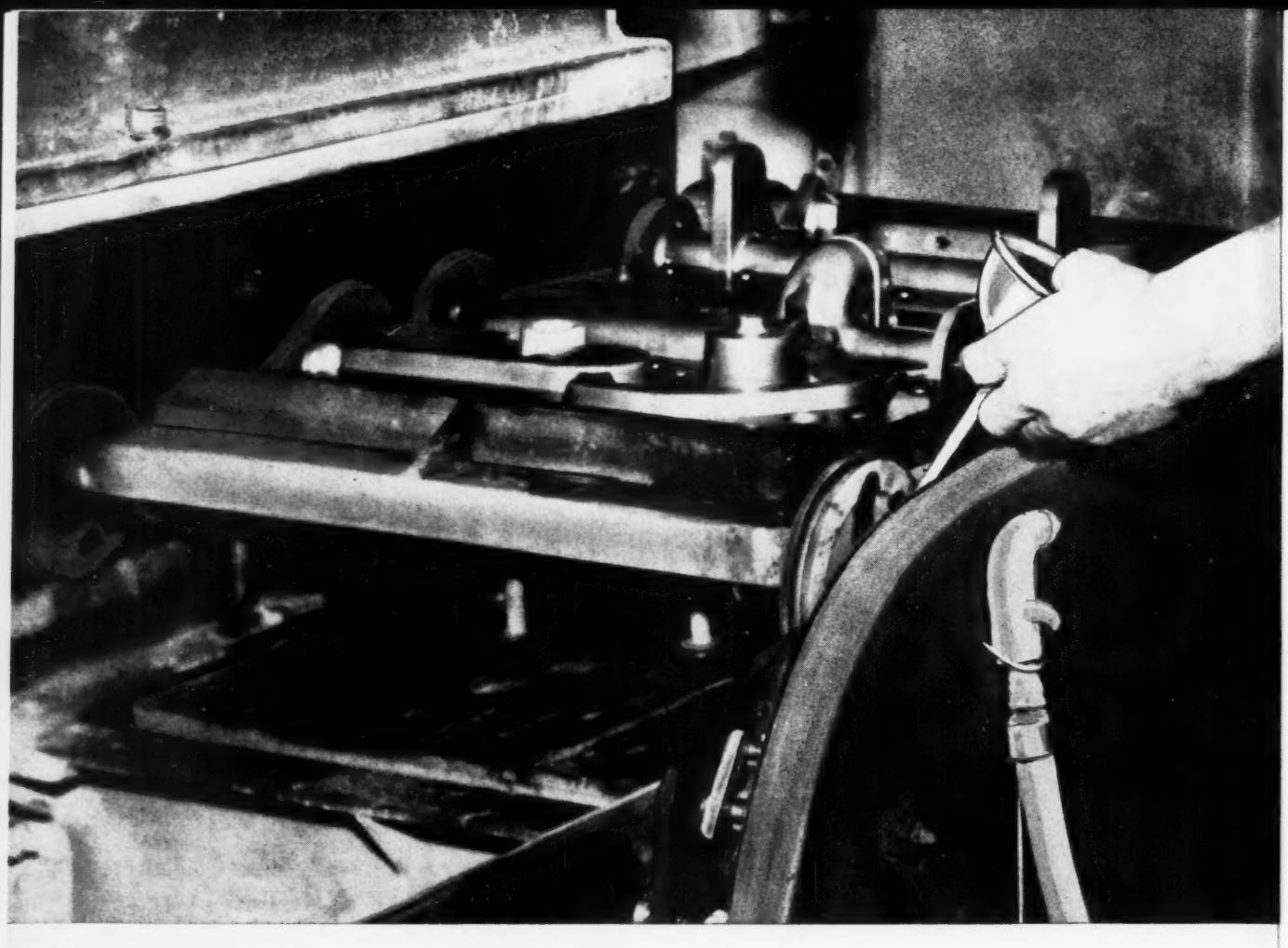

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Production Pattern & Foundry Company of Chicopee, Mass. runs its five shell-molding machines 24 hours a day to keep up with casting-floor demand for molds. To stand up under this tough service, the machines must be properly maintained.

Maintenance personnel at Production Pattern & Foundry have found that lubrication instructions of the machine's manufacturer have paid off handsomely. Shell Process Co., which makes these shell-molding machines, recommends **'Oildag'** — colloidal graphite in petroleum oil — diluted with five parts of No. 10 oil for the lubrication of critical wear points: the axle bearings of the drive mechanism, and hitch-pivots and link pins of the roller chain. Since the roller chain is subjected to 900° F temperatures within the shell-baking oven, conventional lubricants would be useless . . . would decompose and carbonize. Proof of the effectiveness of colloidal graphite for this heavy-duty high-temperature lubrication job is the fact that the machines have operated without breakdown for more than six years!

Dispersions of colloidal graphite are extremely valuable elsewhere in the foundry too: as long-lasting lubricants for moving parts of casting machines and other foundry mechanisms; as heat-resistant ladle coatings, and effective mold coatings for better parting and controlled cooling. You can learn more about the use of **'dag'** dispersions in metal-casting operations through Acheson's Bulletin 425. Write for your free copy today.

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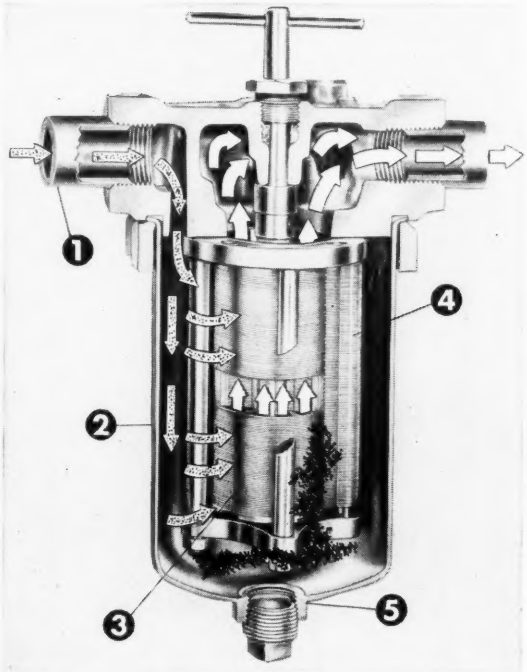

HOW IT WORKS. Dirty oil enters inlet (1) at left, fills housing (2) and flows through metal edge-type filter. (3) Clean oil rises through center of filter, leaves at right. Dirt combed out by cleaner blades (4) is removed through drain (5).

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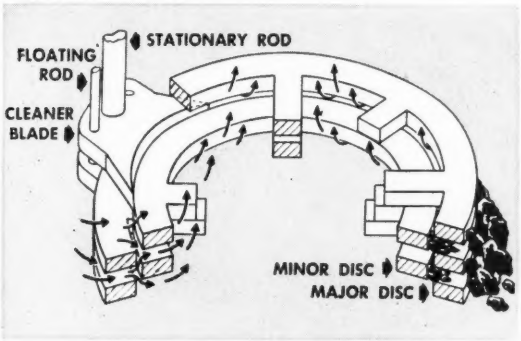
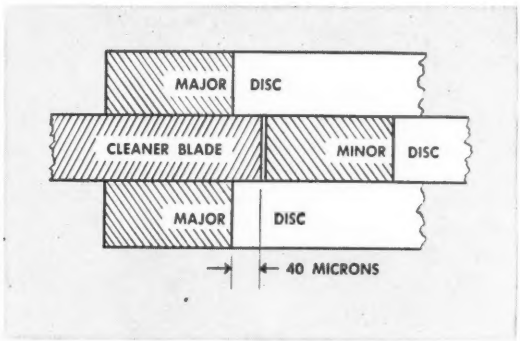


FILTER ELEMENT consists of stacked major and minor discs and cleaner blade bearing against precision ground minor disc. Oil flow is shown by arrows.



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ASLE News Notebook

BOARD ACTIONS

January 19, 1956

To be consistent with the raise in dues for members during 1956, the dues of student members were raised to $5.00 per year, and associate members dues were raised to $7.50.

Action on reduced dues for foreign members was tabled so that further study of this action could be made.

A reorganization of the Technical Committee structure was recommended by the Organization and Operations Committee (see complete report printed under committee reports) and approved by motion of the board.

The board agreed to consider the Los Angeles area for the 1958 Lubrication Conference.

April 3, 1956

Elections were held by the board for officers for the new board year 1956-57. The following officers were elected:

VICE-PRESIDENT AT LARGE — E. R. Booser, General Electric Co.*

SECRETARY — J. L. Finkelmann, Warren Refining & Chemical Co.

TREASURER — J. W. Peterson, Standard Oil of Indiana

EASTERN VICE-PRESIDENT—J. O. McLean, Reynolds Metal Co.

MIDWESTERN VICE-PRESIDENT — A. B. Wilder, E. I. du Pont de Nemours & Co.

WESTERN VICE-PRESIDENT — L. M. Tichvinsky, University of California

CANADIAN VICE-PRESIDENT — B. H. Miller, Imperial Oil Co. Ltd.

New board members elected by ballot of the members in March were introduced.

INDUSTRIAL DIRECTOR — C. T. Lewis, U. S. Steel Co., replacing J. L. Finkelmann.

DIRECTORS — D. W. Sawyer, Aluminum Co. of America; and D. M. Cleaveland, Bendix Aviation Co., replacing retiring directors W. H. Millett and R. H. Josephson.

Note: The Industrial Director is elected for a two-year term and Member Directors are elected for terms of three years.

The By-Laws Committee was requested to consider the inclusion of a new grade of membership, "Fellow", into the membership structure. This grade would be applied to retiring members after long years of service to the Society. Full membership privileges would be accorded and dues waived.

Mr. W. H. Millett was appointed chairman of the By-Laws committee and was requested to compile an up to date set of By-Laws and Resolutions.

The Board moved to cooperate with the newly formed National Railroad Lubrication Conference on all problems of mutual concern. A liaison member will be appointed to represent ASLE in this activity.

The Board decided against participation in the Conference on Lubrication and Wear sponsored by the INSTITUTE OF MECHANICAL ENGINEERS (England) but agreed to invite the IME to participate in the 1957 joint ASLE/ASME Lubrication Conference in Toronto.

Because of the death of President-Elect Deutsch, E. R. Booser becomes President for 1956-57 and a new Vice-President at Large will be elected at the June Board meeting.

COMMITTEE REPORTS

JANUARY 19, 1956

COMMITTEE ON NOMINATIONS

A tentative slate of candidates was reported on for officers of the Society for the year 1956-1957 *(See Board Actions for April).*

GENERAL TECHNICAL COMMITTEE

Membership in the Technical Committee has increased from 85 to 115 during the past six months. The newly formed Gear Committee under the Chairmanship of S. R. Calish is fully staffed.

EDITORIAL COMMITTEE

Plans are under way for advancing Lubrication Engineering to a monthly basis. Before this can be accomplished improved news and feature articles, better liason between local Sections and the National Office and a survey of economic factors effecting this transition to the yearly basis must be made.

ANNUAL MEETING COMMITTEE

Details treating the 1956 meeting in Pittsburgh have been completed including plans for the ladies' program.

AWARDS COMMITTEE

Special citations were recommended for retiring treasurer W. H. Fowler, Jr. and the retiring editor of Lubrication Engineering, S. K. Talley, because of their outstanding contributions to the welfare of this Society.

PROGRAM COMMITTEE

Seventeen full sessions have been planned for the 1956 Annual Meeting, including a new Automotive Session. A total of 47 papers have been offered and 16 have been submitted. The Program Committee suggest that preprinting of papers would be desirable for future meetings. To alleviate the serious shortage of speakers listed on the Speakers' Bureau, several suggestions were offered: (1) hold joint meetings between several Sections, (2) hold meetings on consecutive nights in a geographic location so that a speaker need not travel five or six times a year to an area, and (3) provide better attendance at meetings when a noted speaker is appearing, by more extensive publicity directed at non-ASLE members living in the area adjoining the Section.

JOURNAL BEARING RESEARCH

Work on this project is complete and publication is being planned.

HANDBOOK ADVISORY COMMITTEE

An outline of the handbook and a schedule of the work is complete. Selection of the authors to write the various chapters is in progress.

(Continued on next page)

The late Mr. Wilbur Deutsch, President Elect, as he addressed the members at the Annual Meeting in Pittsburgh. Seated at the table are past President J. W. Hopkinson, L. B. Sargent, Jr., Chairman of the Pittsburgh Section, and W. H. Fowler, Jr., retiring Treasurer.

ADMINISTRATIVE SECRETARY'S REPORT

New promotional membership forms have been completed to assist in securing new members and sectional sustaining members.

New Society jewelry has been obtained *(See Page 134 March-April 1956 issue of Lubrication Engineering)* and will be made available to members through the National Office.

Because of the joint efforts of ASLE and the National Railroad Lubrication Council (NRLC), 40 Chief Test Engineers of major railroads are now members of ASLE. Three AAR (Association of American Railroads) papers will be presented at the annual meeting as a result of this cooperation.

The Organization and Operations Committee was requested to investigate the inclusion of vertical industry committees into the Technical Committee structure of the Society, in view of the extremely successful effort with the railroad group.

COMMITTEE REPORTS

APRIL 3, 1956

ORGANIZATION AND OPERATIONS COMMITTEE

Based on the request of the January Board Meeting the Organization and Operations Committee recommends the following steps: That the Midwestern region shall be split up into two areas to reduce the travel burden placed on the Midwestern Vice-President. The new proposed region would be called Central Region.

Any industry committees established within the Society will be placed under the jurisdiction of the newly created Technical Advisory Board. A Manual of Operations for Regional Vice-Presidents shall be created. This will reduce the burden of travel and assignments placed on the Regional Vice-Presidents by clarifying their respective duties.

PROJECTS COMMITTEE

Society membership has been broken down by industry and company affiliation by the Projects Committee. The Publication Manager was requested to prepare a study for the Board to indicate the methods for preparing a complete directory of this type.

AWARDS COMMITTEE

The National Awards Committee recommended the following individuals as awards recipients for this year.

CAPTAIN ALFRED E. HUNT AWARD: To Dr. B. Lunn, for his paper, "Evaluating Bearing Materials under Boundary Lubrication," *(See Lubrication Engineering, July-August, 1954, pp. 255-60).*

WALTER D. HODSON AWARD: To Mr. F. Osterle (with Mr. E. Saibel who is commended for his contributions) for the paper, "Recent Advances in Hydrodynamic Theory of Slider-Bearing Lubrication," *(See Lubrication Engineering, May-June 1955, pp. 187-92).*

ASLE NATIONAL AWARD: To Oscar L. Maag for outstanding contributions to the Lubrication Engineering profession within his company and to the Society.

EDITORIAL COMMITTEE

A report is being prepared for the June Board Meeting covering the advertising relationship to operation of the journal which will serve as a planning basis for monthly publication of the journal.

FINANCE COMMITTEE

The successful financial operations of the Society has permitted transferring additional funds to the reserve account during the last year.

JOURNAL BEARING RESEARCH PROJECT

The edited version of Professor Fuller's work will be completed this year and published immediately thereafter.

PROGRAM COMMITTEE

Almost 30 of the papers constituting the major portion of 17 technical sessions have been preprinted by the authors for distribution at the forthcoming Annual Meeting.

Additional copies of all preprinted papers will be made available through the National Office after the meeting.

BY-LAWS COMMITTEE

Mr. W. H. Millett was appointed Chairman and requested to compile an up to date set of by-laws and resolutions.

ADMINISTRATIVE SECRETARY'S REPORT

Membership has grown in the Society during the past year to more than 2,800 and should exceed 3,000 by the end of the year. Future membership can be anticipated from members of industrial plants. The establishment of industry committees should help to accomplish this membership growth.

THINGS THAT MONEY CANNOT BUY

Annual Meeting Banquet Address by Retiring President J. W. Hopkinson

I know each retiring president must feel as I do tonight — somewhat like a kid that is carrying his final report card home from school. And as he walks along, he reflects that it is a pretty good card, but it could have been better. He makes a mental resolution that he will continue to work in the months ahead to complete his objectives.

After four years of close study—and considerable consultation with past and present officers and directors, I became dedicated to the proposition that we must do something right now in our planning for future growth of our Society.

We would have to spread responsibility and delegate authority—through our expanded technical committees.

This has been accomplished through the Organization and Operations Committee under the chairmanship of Eugene Merchant. Many new technical committees have been formed, and membership in the committees has grown from 60 to more

than 170. The work load on your president has been relieved by delegation of specific duties to the various officers, directors, and committees of the Society.

Perhaps the most important part of my message to you may appear repetitious to the committee chairmen attending the president's annual dinner last night, but the words I expressed to them last night apply equally to each of you who contribute so much to the success of the Society.

When I spoke of things that money cannot buy — money cannot buy the full measure of satisfaction that the Pittsburgh Section must have experienced because of the tremendous success they have made of this annual meeting.

Did you ever stop to reflect that organizations, like individuals, have personality, character, intelligence, loyalty, and sometimes glamour? I use this illustration as a means of telling you that you have contributed all of these qualities to ASLE in the work that each of you has done during the past year. I am truly thankful that we have men of your caliber, men that can take time out from their every day work to contribute as much to our Society's growth as you gentlemen have in the past year.

It is my earnest plea that you continue to partake of the fellowship and reap the individual benefits accruing from active participation in the activities of the Society — *for these are things that money cannot buy.*

ASLE National Awards Address

by J. H. Fuller, Director, ASLE (Representing the Awards Committee)

"Tonight, in the interest of hearing our speaker, we will cite the awards rather than have a formal presentation. Award Recipients present tonight are requested to stand at their place and actual awards will be transmitted later.

"Our first award, the *ASLE National Award*, is being made to a man who has materially contributed to the field of lubrication engineering through his excellent and constructive work for his company, as well as participation in our Society and other technical societies. He was on the original Board of Directors of ASLE and was our second President. This year's recipient is Oscar Maag.

O. L. Maag
ASLE National Award

W. H. Fowler, Jr.

S. K. Talley

"Our next award, the *Captain Alfred E. Hunt Memorial Award*, consists of a medal in recognition of the best paper either published in our Journal or presented before a meeting of ASLE in the past year by a member. This year the paper selected is "Evaluating Bearing Materials under Boundary Lubrication" by B. Lunn of Copenhagen, Denmark. Mr. Lunn could not be with us tonight.

B. Lunn
Alfred E. Hunt Award

"The third award is the *Walter D. Hodson Jr. Award.* This is in recognition of the best paper published in *Lubrication Engineering* or presented before a meeting of the Society during the past year by a member of the Society, 30 years of age or less. The paper selected this year was "Recent Advances in Hydrodynamic Theory of Slider Bearing Lubrication" authored by Mr. F. Osterle and Mr. E. Saibel. Mr. Osterle, a member under 30 years, is the recipient of the award, and Mr. Saibel is to be complimented for his contribution to this paper. Will Mr. Osterle Stand?

"It was the feeling of the Board of Directors and the Awards Committee that two members of the Society deserve special recognition and appropriate certificates of appreciation for jobs well done in serving the Society. Mr. W. H. Fowler, Jr., retiring this year as treasurer, has served in this position, and originally as Secretary-Treasurer, for four years. He has sacrificed an enormous amount of his personal time and effort to this job. Our present excellent financial condition is the best evidence of his endeavors. The Society expresses its thanks; Bill Fowler please stand.

"Dr. S. K. Talley has retired as editor of *Lubrication Engineering*. Through his ability and untiring efforts our journal has consistently contained technical information of the highest order and of immense value to each of us. His services are greatly appreciated. Dr. Talley please stand."

Presentation of the President's award to J. W. Hopkinson was made by J. Boyd, which concluded the formal presentations for 1955.

F. Osterle
Walter D. Hodson Award

3rd
ASME-ASLE
Lubrication Conference
Chalfonte-Haddon Hall
Atlantic City, N. J.
Oct. 8-9-10, 1956

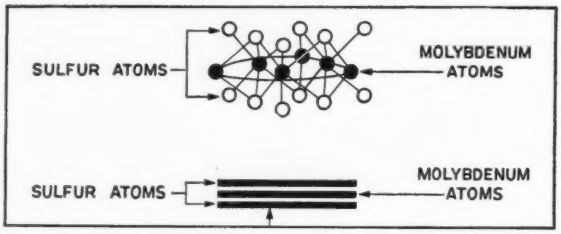
Effective lubrication of torsion suspension bushings of heavy duty trailers has been a maintenance problem with many truckers. The bushing at the left was removed still in good condition after 160,000 miles of service. This bushing was lubricated with a chassis grease containing Moly-Sulfide additive. The bushing at the right, lubricated with ordinary chassis grease, needed replacement after 35,000 miles of service.

How Moly-Sulfide additives EXTEND EFFECTIVE LUBRICATION

Why Moly-Sulfide additives are used in lubricants by trucking fleet operators, railroads, aircraft and automotive manufacturers, oil well drillers and steel mills.

Moly-Sulfide has six characteristics which make it an ideal lubricant additive wherever mechanical action wipes or shears off the hydrodynamic film.

1. Because of its affinity for metals, Moly-Sulfide readily forms a film on metal surfaces.
2. Moly-Sulfide has a low coefficient of friction.
3. It has a high factor of durability.
4. Moly-Sulfide has a thermal stability of −100°F. to +750°F.
5. It has a high chemical resistance to acids, alkalis and water.
6. It withstands high pressures, having a low shear strength and a high film strength.

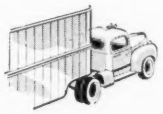


Above, structural diagram of the Moly-Sulfide molecule. Below is a functional illustration of the laminar structure. Each lamina is composed of a layer of molybdenum atoms with a layer of sulfur atoms on each side.

What is Moly-Sulfide and how does it function in lubrication?

Mined in Colorado as molybdenite, purified Moly-Sulfide is a lead-grey material. It has a laminar molecular structure, with the Moly atoms sandwiched between layers of sulfur. (See illustration.) The sulfur atoms have an affinity for metal and

bond readily to metal surfaces, giving the film a *low shear strength.* This affinity is caused by a strong intermolecular bond between sulfur and metal. The lubrication results from the easy slippage of sulfur-to-sulfur atoms. As an additive to lubricants, the *Moly-Sulfide will readily form a film and when a grease or oil film is wiped away or sheared off, the Moly-Sulfide film sustains lubrication until a petroleum film reforms.*



Truck and passenger car builders and operators are making wide use of Moly-Sulfide greases for difficult lubrication jobs.

Lubricants containing Moly-Sulfide additive have over 30 established uses in the automotive, aircraft, railroad, oil drilling and steel industries.

Since Abraham Lincoln's time, railroads have been faced with a serious, recurring, *expensive* problem: hotboxes. Right now more than 14 million journal bearings are carrying heavy loads at high speeds on American railroads. These railroads have to deal with an average of 183,000 hotboxes a year at a cost of some $90,000,000.

Initial field tests by at least three leading railroads have shown hotboxes can be reduced materially by the use of grease containing Moly-Sulfide. A way has been devised to apply greases containing Moly-Sulfide on the journals of railroad equipment. This application is supplemental to the oil waste system and as a result the Moly-Sulfide films that are formed sustain lubrication until the oil film is reestablished.

American automobile and truck manufacturers and their customers are now using lubricants containing Moly-Sulfide additive in at least 14 different applications. These include chassis points, ball joint suspensions, torsion suspension assemblies, fifth wheels, shackle bolts, king pins, valve stems, automatic window mechanisms, wind-shield wiper mechanisms, seat adjusters, drive shaft splines.

In aircraft, Moly-Sulfide is added to aircraft greases. In jet engines under exacting conditions of temperature and pressure it is used on turbine shaft, splines and gear reduction units.

In other industries, Moly-Sulfide is being used in lubrication jobs which formerly presented serious difficulties. A Florida cement plant is using gear compound containing Moly-Sulfide to lubricate rack gears and a Michigan manufacturer uses Moly-Sulfide as an additive to drawing compounds for drawing stainless steel hub caps. In New York a baker of crackers and cookies is using Moly-Sulfide grease for lubrication of oven chains which must operate at high temperatures. In Louisiana an oil well drilling contractor is using Moly-Sulfide additive in tool joint compounds. He reports that disjointing when drilling below 15,000 feet is no problem now: no galling, welding or stripped threads.

Aircraft manufacturers are using Moly-Sulfide greases on many types of ball and joint suspension lubrication.

Oil well drilling contractors are using Moly-Sulfide additives to tool joint compounds.

Lubrication engineers are offered information and help in evaluating the use of Moly-Sulfide as an additive to lubricants by the Climax Molybdenum Co.

Currently Moly-Sulfide is being investigated by many petroleum research laboratories and lubricant users. They are interested in studying, under practical working conditions, the ability of Moly-Sulfide to increase effective lubrication.

If insuring effective lubrication is a problem facing your company, Moly-Sulfide additives may be a solution. Climax Molybdenum Company is the principal source of this product. If you need authoritative information, please get in touch with us and we will be pleased to send you literature on Moly-Sulfide and the sources of supply for experimental lubricants containing Moly-Sulfide.

DEPARTMENT 38
CLIMAX MOLYBDENUM COMPANY
500 Fifth Avenue, New York 36, N. Y.

Please send me the following:

Literature
1. "Moly-Sulfide, Lubricant Additive" ☐
2. "Moly-Sulfide in Chassis Grease" ☐
3. "Moly-Sulfide Specification and Properties" ☐

List of Sources for
1. Railroad Greases ☐
2. Chassis Greases ☐

Sample — One-ounce tube of Moly-Sulfide ☐

Name .....

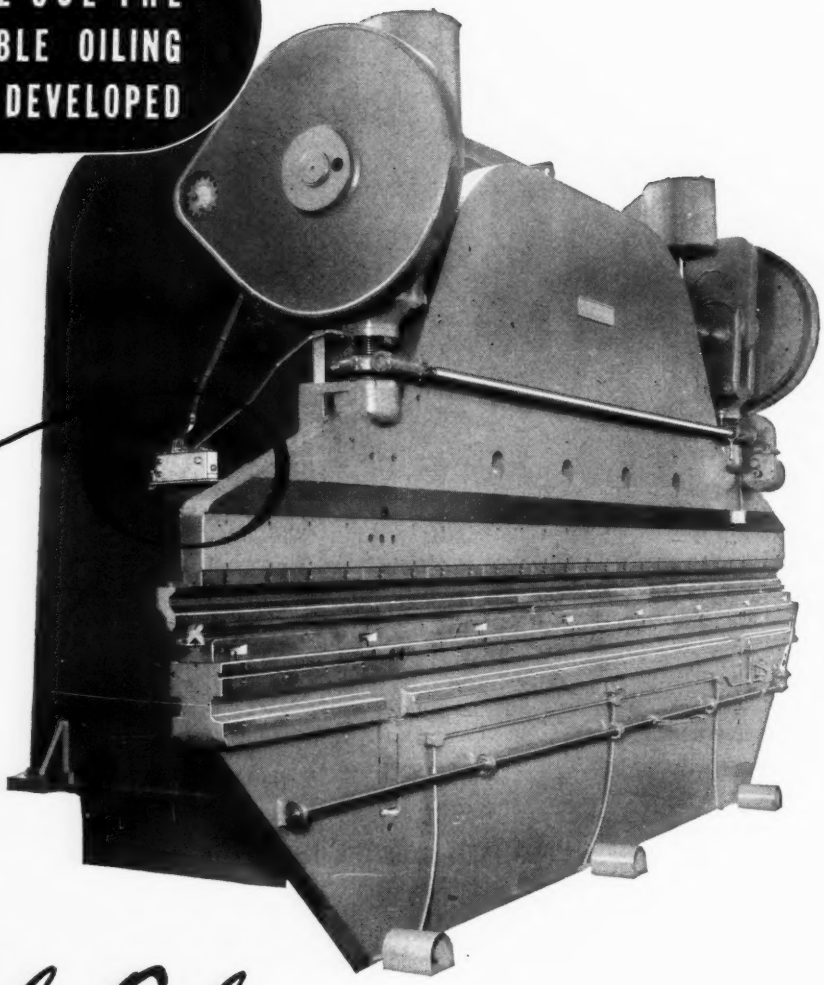
Position .....

Company .....

Address .....

CLIMAX MOLYBDENUM

MACHINES OF GREAT PERFORMANCE USE THE MOST DEPENDABLE OILING SYSTEM EVER DEVELOPED



Illustrated is Madison-Kipp Lubricator Model FD installed as original equipment on a ⅜" by 20' Cincinnati Press Brake, manufactured by the Cincinnati Shaper Co., Cincinnati, Ohio.

MADISON-KIPP *fresh Oil* . . . by the measured drop, from a Madison-Kipp Lubricator is the most dependable method of lubrication ever developed. It is applied as original equipment on America's finest machine tools, work engines and compressors. You will definitely increase your production potential for years to come by specifying Madison-Kipp on all new machines you buy where oil under pressure fed drop by drop can be installed.

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- *Experienced in* LUBRICATION *Engineering*
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Evaluation Of Crankcase Lubricants For Radial Gas Engines

by D. W. Sawyer,* H. D. Keefer,** E. M. Kipp* & R. W. Shaw***

In view of the large volume of oil required annually for the operation of a power plant employing radial gas engines, and because the prime importance of correct lubrication in achieving low repair and maintenance costs, coordinated laboratory and field investigations were undertaken by the Aluminum Company of America to study the operating characteristics of the various types of oils that might possibly be used. Excessive ring wear occurred in the field tests with oils having viscosity indices of less than 70. Upper cylinder lubrication appears to be the most critical factor affecting the lubrication of the radial gas engines. Carbon deposition is second in importance. Tentative purchase specifications have been set up for the oils to be used in the lubrication of both the eleven- and twelve-cylinder radial gas engines.

Aluminum Company of America operates a smelting plant at Point Comfort, Texas, having a yearly capacity of 90,000 tons of aluminum pig. The plant is located some 135 miles south of Houston on Matagorda Bay.

The direct current used in operating the five-pot lines in this plant is generated in the largest internal combustion engine generator installation in the world. The power plant consists of 194 two-cycle Nordberg spark-fired gas burning engines which supply nearly 350,000 horsepower. These engines have a bore of 14 inches and a stroke of 16 inches, and are operated at 360 to 400 rpm.

The original installation in this plant consisted of 120 eleven-cylinder engines which were located in three buildings each containing 40 engines. These engines, each of which develops 1800 horsepower, supply direct current for three-pot lines. In 1952, a little over two years after the plant poured its first metal, two additional pot lines were added. The power to operate these pot lines is supplied by 74 twelve-cylinder radial engines located in two buildings each containing 37 engines. Each of these 12-cylinder engines developes 1925 to 2125 horsepower. Fig. 1 shows a general view of one of the power houses. A close-up of one of the engines is shown in Fig. 2.

Each engine is arranged with port scavenging and port exhaust, and the intake and the exhaust are timed by the pistons as they uncover the ports in the cylinder walls.

The engines are of the dry sump type, each requiring 500 gal. of crankcase oil as an initial fill. The crankcase oil is maintained by means of a by-pass filter using 40 to 80 mesh activated alumina Grade F3 as the filter media on each engine. In addition to these filters, the twelve-cylinder engines are also equipped with full-flow oil filters. Periodically the alumina is removed from the by-pass filters, reactivated by controlled combustion of the contaminants, and returned for further service.

Considerable quantities of oil are consumed annually in this power plant both as crankcase oil make-up and for upper cylinder lubrication. The oil used in the crankcase lubricating system is also used in the lubricators supplying oil to the cylinders.

The upper cylinders are lubricated with Manzel forced-feed lubricators which inject the oil into the cylinders at 40 psi.

The bearings, gears, and other moving parts are lubricated by a continuous pressure system which circulates 190 gallons of lubricating oil per minute at a pressure of 30 psi. The pistons are oil cooled from the same pressure system. The oil passes

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**ALCOA, Comfort Works, Port Lavaca, Texas.

***ALCOA, 1200 Alcoa Bldg., Pittsburgh 19, Pa.

from the crank through the master bearing around the knuckle pins, and through the connecting rods to the passageways in the piston head. After circulating through the piston head passages and cooling the piston, the oil is returned through the connecting rods and knuckle pins, and discharged back into the system for cooling and recirculating.

In view of the large volume of oil required annually for this plant, and because of the prime importance of correct lubrication in achieving low repair and maintenance costs, coordinated laboratory and field investigations were undertaken to study the operating characteristics of the various types of oils that might possibly be used. The oil covered a wide variety of types ranging from straight low-Viscosity Index naphthenic oils to detergent oils of the type meeting U. S. Army 2-104B and MIL-0-2104 specifications.

Because of the obvious practical necessity of limiting full-scale field testing to as small a number of different oils as possible, preliminary screening tests of a large number of representative types of oils were run using Lauson engines. On the basis of the Lauson engine test procedures, arbitrary classifications of the test oils were made from which a minimum number of most representative oils were then selected for the full-scale field tests at Point Comfort.

EXPERIMENTAL PROCEDURE. The following five basic types of oils having a viscosity in the range of from 600 to 790 SSU / 100 F. were included in three studies:

(1) Straight low-Viscosity Index naphthenic mineral oils with viscosity indices covering a range from —10 to 40.

(2) Straight solvent-refined medium-Viscosity Index naphthenic mineral oils with viscosity indices covering a range from 40 to 65.

(3) Straight high-Viscosity Index paraffinic mineral oils with viscosity indices covering a range from 80 to 100.

(4) Oxidation-inhibited high-Viscosity Index mineral oils with viscosity indices covering a range from 80 to 105.

(5) Heavy-duty detergent mineral oils meeting U. S. Army Specification 2-104B with viscosity indices covering a range from 60 to 100.

LAUSON ENGINE SCREENING TEST. Early in 1949 when the Point Comfort plant was under construction, a preliminary laboratory screening procedure was set up to classify the various oils in each of the five series. Model H2 Lauson test engines were used for this purpose. Eight engines were installed in the Engine Laboratory of Aluminum Company of America's Development Division at Cleveland, Ohio. These engines were designed primarily for oil evaluation work employing gasoline as a fuel; however, by making a few minor changes, the engines were converted for operation on natural gas. Natural gas was used in this work, since the radial gas engines in the Point Comfort plant were to operate on natural gas.

A general layout of the Engine Laboratory is shown in Fig. 3. The Cities Service exhaust gas

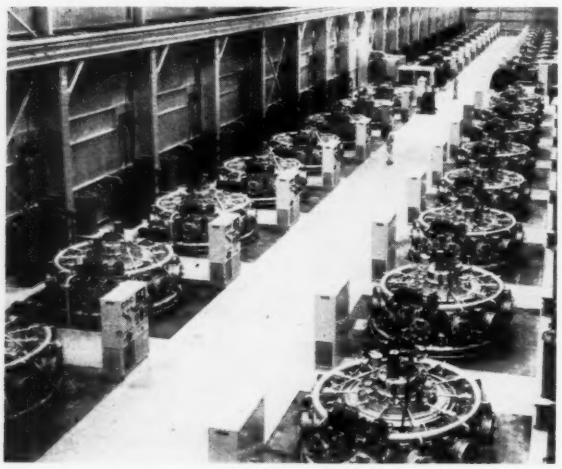

Fig 1. General view of power house containing 40 Nordberg radial gas engines.

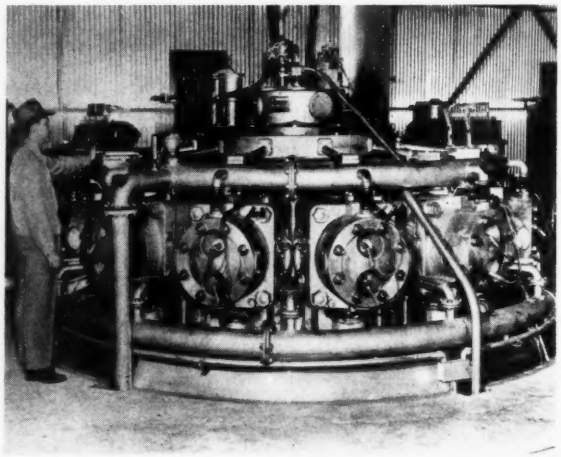

Fig. 2. Close-up view of 12-cylinder Nordberg radial gas engines.

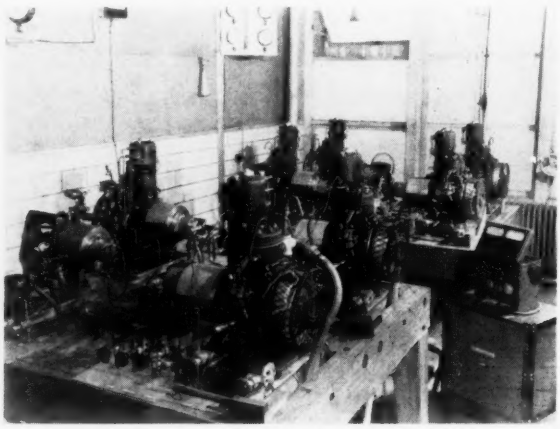

Fig. 3. General view of Lauson engine laboratory used in oil evaluation program.

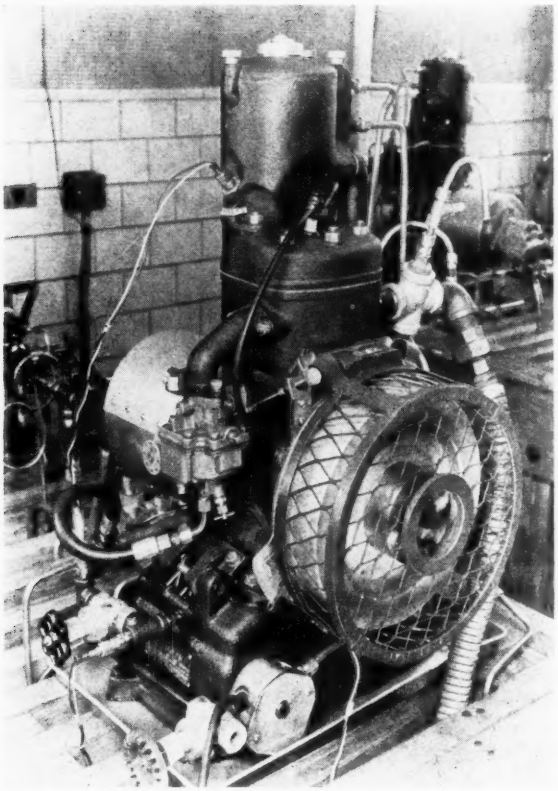

Fig. 4. Close-up view of Lauson engine.

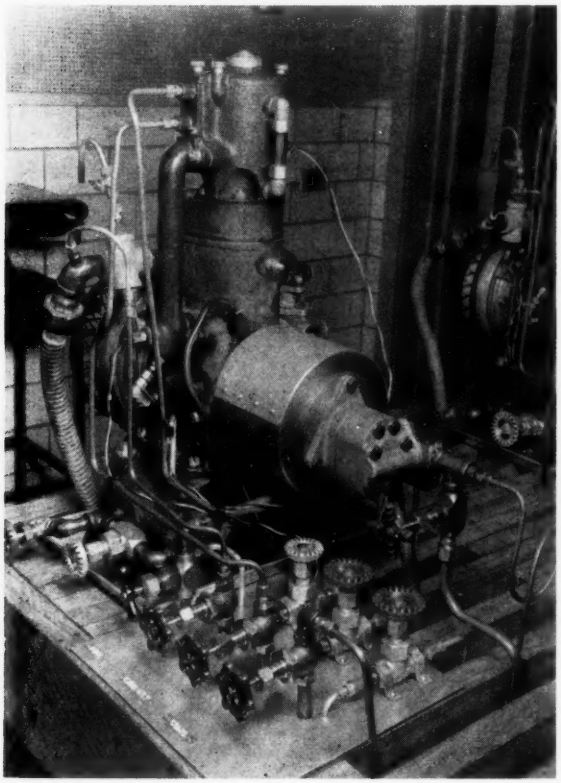

Fig. 5. Close-up view of Lauson engine showing Pesco oil gear pump which was used to load the engine.

analyzer used to control the air-fuel ratio in the tests is shown at the extreme right of the photograph.

Figs. 4 & 5 are two views of one of the Lauson engines. The Pesco oil gear pump, which was used to load the engine, is shown at the extreme right of the engine in Fig. 5.

The remote control instruments, which were located on a desk on the outside of the engine room, are shown in Fig. 6. The operator, by means of these controls, could take readings such as crankcase temperature and engine speed for each engine.

The Lauson engine bench test was used as a screening test for selection of representative oils from each of the five basic types for subsequent full-scale performance testing in the radial gas engines.

The Lauson engine tests were originally designed to determine such qualities of the oils as corrosiveness to bearings, ring sticking, carbon and varnish deposits, sludging qualities, and oxidation stability. Subsequent performance tests indicated good correlation on these points with the laboratory Lauson engine data. The Lauson screening tests did not, however, correctly predict the factor of ring wear in the radial gas engines as was later shown by means of the field tests. It is of considerable interest, however, that later Lauson engine tests, specifically designed to emphasize and predict probable ring wear in the full-scale gas engines, disclosed that it was entirely feasible to satisfactorily correlate the effect of crankcase oils upon ring wear in the full-scale engines with the Lauson engine laboratory ratings. In the latter tests, rings irradiated in an atomic pile were used.

The test procedure used in the Lauson engine screening tests consisted of first completely disassembling and thoroughly cleaning the interior of the engine. New piston and ring assemblies and new copper-lead connecting rod bearings were used in each test. The bearings were carefully weighed so that any weight loss during the test could be determined. Each oil was evaluated using the following two sets of conditions:

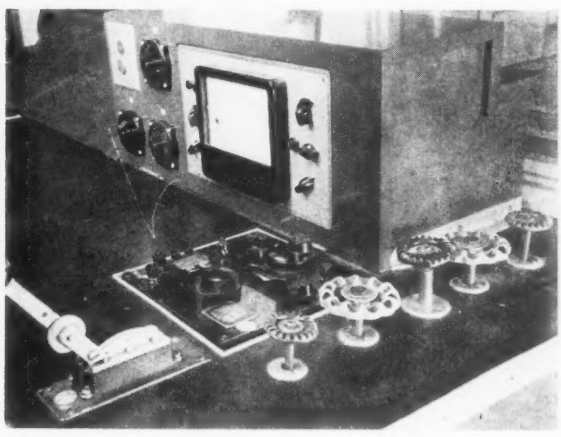

Fig. 6. Remote control instruments used in Lauson engine evaluation program. This desk was located outside engine room.

(1) High Temperature, Short-Time Tests: time of test, 60 hrs.; oil sump temperature, 280 F.; water jacket outlet temperature, 212 F.; initial oil fill, 2.65 to 2.75 lbs.; engine speed, 2000 rpm; fuel, natural gas (sulfur content <0.1 gram per 100 cubic feet of gas).

(2) Low Temperature, Long-Time Tests: time of test, 240 hrs.; oil sump temperature, 200 F.; water jacket outlet temperature, 212 F.; inlet oil fill, 2.65 to 2.75 lbs.; engine speed, 2000 rpm; fuel, natural gas (sulfur content <0.1 gram per 100 cubic feet of gas).

Under both sets of conditions the engines were operated as close to full load as possible, with the air-fuel ratio adjusted so that the exhaust gases contained 5 to 6% oxygen and zero percent combustibles. A Cities Service exhaust gas analyzer was used to measure the exhaust gas.

During the tests, temperature readings, pressure, and RPM were measured every two hours. Oil level checks and air-fuel ratio were checked every six hours. An oil sample was taken at the end of each twelve hours of operation for determination of the neutralization and interfacial tension values.

In the 240-hour tests, because of the length of the test, it was necessary to make oil additions during the test. Every 24 hours a weight of oil equal to that drained out of the crankcase for the two 12-hour samples was added to the sump. Duplicate runs were made for each oil with additional runs in those cases where the two initial runs were not in agreement.

Inspection of Engine Parts in Lauson Engine Tests. At the end of each test the oil was drained out of the engine, weighed, and the oil consumption thus determined. The engine was then disassembled for inspection.

The over-all appearance of the insides of the engine, as to cleanliness and amount of sludge deposited in the crankcase and on the engine parts, was measured. The amount of sludge was rated using a scale ranging from 10 (none) to 0 (heavy). The amount of sludge present was used as a measure of both stability and detergent properties of the oil.

The pistons were removed from the engine, inspected for deposits, and given an over-all weighted deposit rating. Included in this rating were the following factors: (1) carbon in grooves, (2) lacquering in grooves, (3) deposits on crown, (4) deposits on skirt, and (5) deposits on oil ring slots.

The scale used in the over-all weighted piston deposit rating ranged from 130 for the highest possible score for a perfect piston, to 0 for the lowest possible rating for a very poor piston. The extent of the deposits on the piston was used as a measure of the tendency of the oil to form varnish, as well as a measure of the oxidation stability of the oil.

The number and degree of ring sticking on the piston were tabulated. A free ring dropped in the grooves by its own weight, a sluggish ring needed assistance to move in the groove, a pinched ring was one that was tight in one spot but the remainder of the ring was free to move, and a stuck ring was one that was immobile in its groove.

The connecting rod bearings were removed from the engine and any loss in weight was determined. A weight loss in the bearings was used as a measure of the corrosive action of the oil. It is to be pointed out, however, that copper-lead bear-

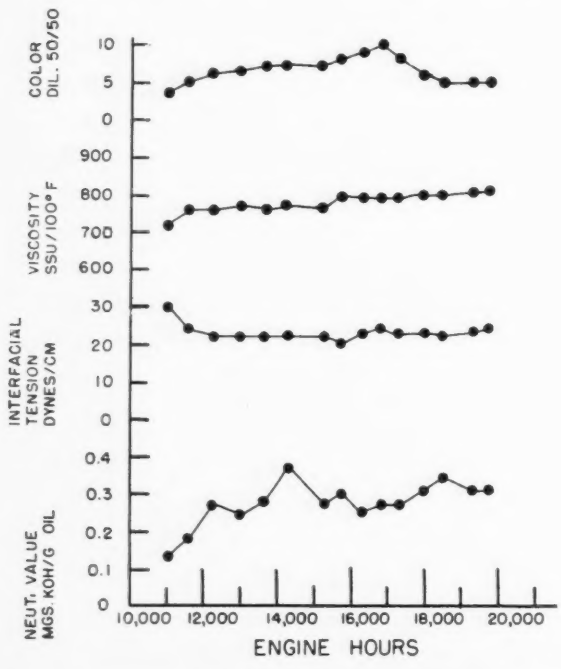

Fig. 7. Full-scale engine test of oxidation-inhibited high-Viscosity Index mineral oil; oil inspection data.

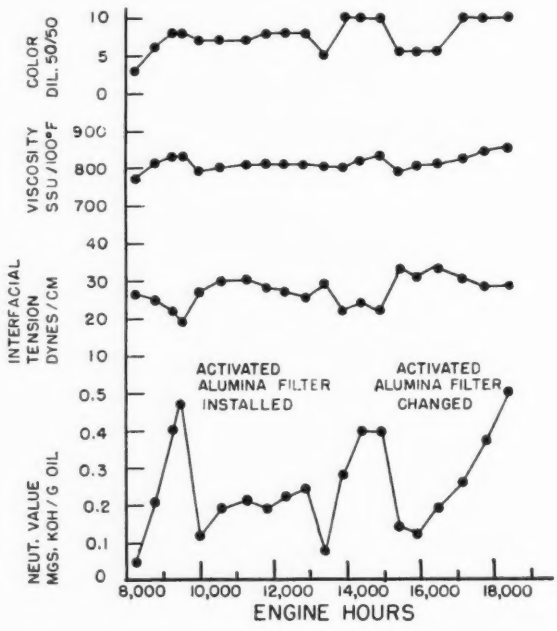

Fig. 8. Full-scale engine test of oxidation-inhibited high-Viscosity Index mineral oil in which cellulose waste filter was replaced with activated alumina filter after 1000 hours operation.

ings are known to be far more susceptible to corrosion than the aluminum alloy bearings which are being used in the Nordberg radial gas engines.

Inspection of Oil. At the conclusion of each test, the following chemical and physical properties of the oils were determined:

Property	Units	Methods Used
Neutralization Value	Milligrams of KOH/g. oil	ASTM D664-52
Interfacial Tension	Dynes/centimeter	ASTM D971-50
Viscosity	SSU at 100 F.	ASTM D445
Saponification No.	Milligrams of KOH/g. oil	ASTM D939-52
Color No.	Union Colorimeter Units	ASTM D155-45T
Naphtha Insolubles	Percent	Continental Oil Co.[1]
Chloroform Insolubles	Percent	"
Naphtha Solubles of Chloroform Insolubles	Percent	"
Oxidation Stability	Hours	Modification of Continental Oil oxidation test[2]

In order to obtain an over-all rating for each oil, the engine and oil inspection data were broken down into three groups, with the individual values in each group being given an arbitrary weighted factor as shown in Table I.

By examining this table, it can be seen that greater weight was placed on the engine rating data than upon the oil rating data. The bearing weight losses were given lower ratings than the other engine factors, since it is known that copper-lead bearings are rather susceptible to attack by decomposition products of the oil; whereas, the aluminum alloy bearings of the Nordberg radial engines are relatively immune to attack by these decomposition products.[3]

Using the indicated weighted factors of Table I, and the individual engine and oil inspection values, a total engine rating and a total oil rating were obtained for each oil for both the 60- and 240-hour tests. These ratings, together with the rating for the modified Continental Oil oxidation test, were also combined to give an over-all rating for each oil. It was presumed that the higher the rating, the better the oil, the highest rating possible being 69 under this system.

A typical example of the type of data obtained is shown in Table II. The data of Table II were obtained in the evaluation of a series of oxidation-inhibited high-Viscosity Index oils with viscosity indices covering a range from 80 to 105.

On the basis of the Lauson engine screening tests, three oils from each of the five groups were selected for full-scale engine tests at the Point Comfort plant. The oils selected were those which were favorable in respect to the Lauson engine screening tests, price, and availability to the Point Comfort plant.

Full-Scale Radial Gas Engine Plant Tests. For the full-scale radial gas engine tests at the Point Comfort, Texas, plant, the Alcoa management made available an entire power house of forty engines. This engine house was equipped with the necessary storage tanks, pumps, and piping to enable us to evaluate eleven different oils simultaneously. The

Table I. Weighted factors used for engine and oil values in obtaining an over-all rating for each oil evaluated by means of the Lauson engine screening test.

	Piston Rating	Cu-Pb Bearings Wt. Loss, Mgs.	Crank-case Sludge Rating	Piston Ring Rating
Group 1	118-130	0-<60	9-10	9-8
Weighted Factor	10	3	6	6
Group 2	95-<118	60-<200	6-<9	5-<8
Weighted Factor	5	2	4	4
Group 3	0-<95	200-	0-<6	0-<5
Weighted Factor	3	1	2	2

	Union Oxidation at 115 C., Hrs.	Increase in Neutralization Value, Mgs. KOH/g. oil	Increase in Saponification No., Mgs. KOH/g. oil	Percent Decrease in Interfacial Tension
Group 1	150-	0-<.5	0-<3	0-<25
Weighted Factor	5	1	1	1
Group 2	40-<150	.5-<1.5	3-<10	25-<60
Weighted Factor	3	0.5	0.5	0.5
Group 3	0-<40	1.5-	10-	60-100
Weighted Factor	1	0	0	0

	Percent Increase in Viscosity at 100 F.	Chloroform Insolubles, Percent	Naphtha Insolubles, Percent	Chloroform Solubles of Naphtha Insolubles, Percent
Group 1	0-<10	0-<.05	0-<.3	0-<40
Weighted Factor	1	1	1	1
Group 2	10-<20	.05-<.15	.3-<1	40-<60
Weighted Factor	0.5	0.5	0.5	0.5
Group 3	20-	.15-	1-	60-
Weighted Factor	0	0	0	0

Table II. Summary of screening tests using Lauson engine for series of oxidation-inhibited high-Viscosity Index mineral oils; the over-all rating of each oil. Key: (*) The higher the rating the better the oil, with the highest rating possible being 69.

	60 Hour Test		240 Hour Test		Modified Continental Oil Oxidation Test Rating	Over-all Rating* (Sum of 5 Ratings)
Oil	Total Engine Rating	Total Oil Rating	Total Engine Rating	Total Oil Rating		
A	18	4	18	3.5	1	44.5
B	18	5.5	18	3.5	3	48
C	18	3.5	18	4	3	46.5
D	18	4	16	4	3	45
E	20	4	16	3.5	3	46.5
F	18	4	16	5.5	3	48.5
G	20	3	18	3.5	3	47.5
H	14	2	16	3.5	1	36.5
I	16	4.5	15	4	1	40.5
J	18	4	16	4.5	3	47.5
K	18	3.5	14	4.5	1	41
L	21	5	20	4	5	55
M	23	4.5	16	4.5	3	51
N	19	1.5	16	5	5	46
O	21	2	18	5	5	51
P	22	3.5	25	4.5	1	56

setup made it possible to evaluate each oil in three engines under full-scale field conditions. Unless some unusual development occurred, such as excessive ring wear, each engine test was conducted for approximately one year.

Inspection of Engine Parts in Full-Scale Engine Tests. The test engines were dismantled prior to the test run, clean pistons and new rings were installed, the engine inspected, and the necessary measurements made and recorded. This inspection included the following items:

(1) A visual examination was made of each piston during which the condition of the face and crown, ring grooves, lands, and skirts was noted.

(2) A visual examination was made of each ring in which its general condition was noted. The ring to land clearance was measured by means of a feeler gauge. In addition, the ring gaps were also measured.

(3) A visual examination was made of each cylinder including the ports. Measurements of the cylinder bore were made with a micrometer at the vertical cylinder 4" from the head, at the horizontal cylinder bore 4" from the head, at No. 2 exhaust port bridge (left to right), at No. 3 exhaust port bridge (center), and at No. 4 exhaust port bridge.

(4) A visual inspection was made of the crankcase cover bearing, pinion gear, master gear, main bearings, and Faxfilm replicas taken of bearing and gear teeth surfaces.

(5) Measurements were made of the crankcase cover, pinion gear, master gear, and main bearings.

Intermittent engine or cylinder inspections were made during the tests whenever the opportunity occurred, or whenever the operation of an engine indicated the necessity for such a check. Four or six and twelve-month general inspections were scheduled and performed when engines became available for such checks.

The test engines were operated at full load. Temperature, pressure, and RPM readings were taken at 8-hour intervals, and an average of these readings was recorded every 500 hours. Stops and starts were also recorded. Cylinder lubricators were checked and oil samples were taken every 500 hours, while crankcase oil consumption was computed every 1000 hours of operation.

Both the straight low-Viscosity Index naphthenic mineral oils and the straight high-Viscosity Index paraffinic mineral oils were continuously maintained by 40 to 80 mesh Grade F3 activated alumina by-pass filtration. Filter cartridges were not reactivated until two consecutive neutralization values rose above 0.35 mgs. KOH/g. of oil.

The oxidation-inhibited high-Viscosity Index mineral oils were maintained with cellulose waste filter cartridges until the same neutralization value limits described above were reached. At this time activated alumina filters were installed and similarly controlled for the remainder of the test.

The heavy-duty detergent-type mineral oils were maintained with cellulose waste filters. In addition, three additional test engines were set up for activated alumina filtration in order to study the effects of this filter media upon a fully detergent oil.

Table III. Values used in full-scale engine tests in determining inspection ratings.

Piston Rating							
Grooves - Face & Crown Deposits		Skirt Deposits		Land Deposits		Oil Ring Vent Deposits	
Clean	10	Clean	10	Clean	10	Clean	10
Light	9	Scattered Varnish	9	Varnish	9	Light	8
Light-Medium	8	Light Varnish	8	Trace of Carbon	8	Medium	6
Medium	7	Varnish	7	Light Carbon	7	Heavy	4
Medium-Heavy	6	Varnish-Light Carbon	6	Medium Carbon	5	Very Heavy	2
Heavy	4	Varnish-Medium Carbon	3	Heavy Carbon	3		
Very Heavy	1	Heavy Varnish and Carbon	1	Very Heavy Carbon	1		

Cylinder Deposit Rating		Carbon Hardness Rating		Gear Wear Rating (Faxfilm Replicas)	
Clean	10	Soft	3	No Change	5
Light Varnish Streaks	8	Medium Hard	2	Light Wear	4
Medium Varnish-Light Scuffing	6	Hard	1	Wear-Light Pits	3
Heavy Varnish	4	Very Hard	0	Heavy Wear	2

At the conclusion of each test, the engines were again dismantled, each part inspected, and the results again recorded. These results were rated for comparison purposes using the arbitrary inspection rates given in Table III.

All pistons, cylinder walls, exhaust ports, and crankcases were checked for carbon and varnish deposits for an indication of the varnish- and lacquer-forming tendencies of the oil.

The number and degree of ring sticking and breakage were also recorded.

All piston ring end gaps and cylinder bores were accurately measured. The wear as indicated by these measurements is a definite indication of the effectiveness of the lubricating properties of the oil in the high-temperature cylinder zone.

Ratings were also computed for hardness of carbon deposits, and gear and top cover bearing wear.

Gear wear or the physical condition of the gears was determined from a comparison of Faxfilm replicas of the gear teeth surfaces made at the beginning and end of each test run.

The engine-inspection results were assigned weighted ratings. Whenever possible the actual number of stuck rings, bore measurements, or actual numerical averages were recorded. When only visual inspections were made, as with the pistons, arbitrary values were assumed to enable a numerical comparison to be made of the test units.

Table IV. Values used in obtaining weighted ratings of oils in full-scale engine tests.

Neutralization Value Increase		Interfacial Tension Value Decrease		Viscosity Increase	
Wt.	mgs. KOH/g. oil	Wt.	dynes/cm.	Wt.	SSU/100 F.
6	0- >.02	3	0- >0.5	12	0- > .5
5	.02- >.05	2.5	.5- >1	11	.5- > 10
4	.05- >.10	2	1- >1.5	10	10- > 15
3	.10- >.15	1.5	1.5- >2.5	9	15- > 20
2	.15- >.20	1	2.5- >3.5	8	20- > 25
1	.20- >.25	.5	3.5- >5	7	25- > 30
0	.25-	0	5-	6	30- > 35
				5	35- > 40
				4	40- > 45
				3	45- > 50

Inspection of Oil. A laboratory analysis was made of the oil samples taken every 500 hours from each test engine. The results of these analyses were recorded in graph form. A typical graph of the oil-inspection data taken from one of the test engines is shown in Fig. 7. As can be seen, the oil analysis included determinations for neutralization value, interfacial tension, viscosity, and color.

The oil-analysis results were assigned weighted ratings, and these ratings were applied to the average neutralization value, viscosity increase, and interfacial tension decrease for each oil test. The weighted ratings used are given in Table IV.

RESULTS. All the engine- and oil-inspection ratings were weighted and used to determine the final over-all rating. The over-all rating is the sum of the weighted engine and oil ratings.

The weight values, as shown in Table V, were arbitrarily selected in order to give a relative value to each of the engine conditions observed during the tests. Since the cylinder and ring gap measurements were accurate, and since they appeared to be the most critical items in the lubrication of the radial gas engines at Point Comfort, they were given more weight (a total of 35 points or 15 and 20 points respectively) than any of the other factors. Carbon and varnish deposits, second to wear in evaluation importance, were given a total of 32 points. The remaining engine factors, bearing and gear wear, received 3 and 1 points, respectively. Neither the bearings nor the gears were materially affected by the tests.

The weighted oil ratings were determined from a comparison with the Lauson engine screening tests and the estimated effect the test oils might have upon the economics of filter maintenance. The total weighted oil ratings mounted to about one-fourth of the over-all ratings.

A minimum average increase in neutralization number received 6 points, a like increase in viscosity 12 points, and a minimum decrease in interfacial tension received 3 points. These averages were computed from the oil analyses made during the life of the initial filter charge in order to only evaluate the stability of the new oil.

A typical example of the data obtained and the means of obtaining an over-all rating of an oil are given in Table VI.

Table V. Values used in obtaining weighted ratings of engine inspection data in full-scale engine tests.

Ring Gap		Pistons		Ring Sticking	
Wt.	Rating (in.)	Wt.	Rating	Wt.	Rating
20	0-> .0025	15	120-> 115	5	0->3
19	.0025-> .005	14	115-> 110	4	3->6
18	.005-> .0075	13	110-> 105	3	6->9
17	.0075-> .01	12	105-> 100	2	9->12
16	.01-> .0125	11	100-> 95	1	12->15
15	.0125-> .015	10	95-> 90	0	15-
14	.015-> .0175	9	90-> 85		
13	.0175-> .02	8	85-> 80	Carbon Hardness	
12	.02-> .025	7	80-> 75	3	3
11	.025-> .03	6	75-> 70	2	2
10	.03-> .035	Exhaust Port Deposits		1	1
9	.035-> .04			0	0
8	.04-> .05	5	100-> 95	Crankcase Sludge	
7	.05-> .07	4.5	95-> 90	1	10->9
6	.07-> .1	4	90-> 85	.5	9->8
5	.1-> .2	3.5	85-> 80	0	8-
4	.2-> .5	3	80-> 75	Gear Wear	
3	.5-> 1	2.5	75-> 70	1	5->4
2	1-> 1.5	2	70-> 65	.5	4->3
Cylinder Wear		1.5	65-> 60	0	3-
15	0-> .0001	1	60-> 55		
14	.0001-> .00025	Cylinder Deposits			
13	.00025-> .0004	3	10-> 9.5		
12	.0004-> .00055	2.5	9.5-> 9		
11	.00055-> .0007	2	9-> 8.5		
10	.0007-> .00085	1.5	8.5-> 8		
9	.00085-> .001	1	8-> 7.5		
8	.001-> .0012	0	7.5-		
7	.0012-> .0014				
6	.0014-> .0017				
5	.0017-> .002				
Bearing Wear					
3	0-> .0005				
2	.0005-> .001				
1	.001-> .0015				
0	.0015-				

A summary of the results obtained in the full-scale engine tests is given in Table VII.

From the results obtained during the full-scale engine tests with the straight low-Viscosity Index naphthenic oils with viscosity indices covering a range of from —10 to 40, it became apparent that the viscosity index of an oil was the most critical factor in these tests. Therefore, the series of straight solvent-refined medium-Viscosity Index naphthenic mineral oils were not evaluated.

Oil P listed in Table II had the highest rating of the series of oxidation-inhibited high-Viscosity Index mineral oils in the Lauson engine bench tests. However, in the full-scale engine tests this oil had the lowest rating of the four oils of this type evaluated as shown in Oil J in Table VII. This oil had a low modified Continental Oil Company oxidation test rating.

As shown in Fig. 8 in the full-scale engine tests with Oil J, it was necessary to replace the cellulose waste filter with an activated alumina filter after 1000 hours operation. It is to be noted that the filter had to be reactivated after 5000 hours operation, which is a short filter life for oils of this type. Experience at the Point Comfort plant with these engines has shown that a filter life of from 10,000 to

Table VI. Results of full-scale engine evaluation of an oxidation-inhibited high-Viscosity Index mineral oil. Key: (*) The higher the rating the better, with the highest rating possible being 90.

Test No. G-1 Engines on Test C-28 and C-40					
Designation of Oil - Oil I					
Operation Rates					
Average Number of Starts and Stops/1000 Hours,	2.72				
Average Crankcase Consumption, Gal./Day,	5.85				
Average Cylinder Lubrication Rate, Gal./Day,	5.40				
Engine Rating					
Average Piston Rating,	93	Equals	Weighted	Rating,	10
Average Ring Inspection Rating,	8	"	"	"	3
Average Ring Gap Rating,	.0054	"	"	"	18
Average Cylinder Wear Rating,	.0005	"	"	"	12
Average Cylinder Deposit Rating,	8.5	"	"	"	1.5
Average Exhaust Port Rating,	67.9	"	"	"	2
Average Carbon Hardness Rating,	1	"	"	"	1
Average Crankcase Sludge Rating,	9	"	"	"	1
Average Gear Wear Rating,	4.8	"	"	"	1
Average Top Cover Bearing Wear, (In)	0	"	"	"	3
Total Weighted Engine Rating					52.5
Oil Rating					
Average Neutralization Value Increase	.0682	Equal	Weighted	Rating,	4
Average Interfacial Tension Value Decrease,	1.481	"	"	"	2
Average Viscosity Increase,	10.91	"	"	"	10
Total Weighted Oil Rating					16
Over-all Evaluation Rating (Sum of Above)*	68.5				

14,000 hours can be expected before it is necessary to reactivate.

Table IX summarizes the results obtained from the evaluation of the oils used in the full-scale engine tests in the Lauson engine.

CONCLUSIONS. (1) Correlation between the full-scale engine tests and the Lauson engine bench tests was not satisfactory. This was due primarily to the methods used in analyzing the results in each case. Carbon and varnish deposition received the greatest emphasis in the Lauson engine tests, while ring and cylinder wear was given the greatest consideration in the full-scale engine tests. Later laboratory bench tests, designed to emphasize and predict probable ring and cylinder wear in the full-scale engines, disclosed that it was possible to satisfactorily correlate the effect of crankcase oils upon ring wear in the field engines with the Lauson engine laboratory data.

(2) Excessive ring wear occurred in the full-scale engine tests with less than 500 hours operation with the three straight low-Viscosity Index naphthenic oils having viscosity indices ranging from —10 to 45 (Oils K, L, and M in Table VIII). In addition, excessive ring and cylinder wear also occurred during the first 3000 hours operation with a heavy-duty detergent mineral oil meeting U. S. Army Specification 2-104B and having a Viscosity Index of 67 (Oil F in Table VIII).

Table VII. Summary of results of full-scale engine test oil evaluation program; over-all rating of each oil. Note: The higher the rating, the better the performance.

Oil	Total Engine Rating (Max 69)	Total Oil Rating (Max 21)	Over-all Rating (Max 90)
Straight high-Viscosity Index paraffinic mineral oils			
A	50	13	63
B	49.5	17	66.5
C	49	15.5	64.5
Heavy-duty detergent mineral oils meeting U.S. Army Specification 2-104B			
D (cellulose waste filters)	46.5	15	61.5
D (activated alumina filters)	50	18	68
E	41.5	11	52.5
F	39	10	49
Oxidation-inhibited high-Viscosity Index mineral oil			
G	59	19.5	78.5
H	44.5	18.5	63
I	52.5	16	68.5
J	44.5	7.5	52
Straight low-Viscosity Index naphthenic mineral oil			
K	41	19	60
L	39	7	46
M	38	13	51

(3) All oils having viscosity indices of less than 70 were unsatisfactory for the radial gas engines from a ring and cylinder wear viewpoint. Oils in the 70 to 80 Viscosity Index range have not been evaluated in the full-scale engine tests, and until this work has been carried out a minimum Viscosity Index of 80 has been set for oils to be used in these engines.

(4) With several limitations, such as Viscosity Index, oils that receive an over-all rating of 63 or better in full-scale three-engine qualification field tests appear to be suitable for regular field use in the radial gas engines at Point Comfort.

(5) Sludging of the oil or oxidation stability as measured in laboratory tests appears to be a decisive factor in the full-scale engine tests only when applied to the economics of oil filter maintenance as illustrated in Fig. 8.

(6) Heavy-duty detergent oils show no advantage over high-Viscosity Index paraffinic oils either with or without oxidation inhibitors in the radial gas engines.

(7) As shown with Oil D in Table VII, it appears that activated alumina is satisfactory for lubricant maintenance in the radial gas engines with

Table VIII. Summary of results obtained from engine inspection of full-scale engine test oil; average figures for each oil. Key: (1) Straight Viscosity Index paraffinic mineral oils; (2) Heavy-duty detergent mineral oils meeting U. S. Army Specification 2-104B, (*) cellulose waste filters, (**) activated alumina filters; (3) Oxidation-inhibited high-Viscosity Index mineral oil; (4) Straight low-Viscosity Index naphthenic mineral oil.

Oil	Piston Rating Max 120	No. Tight Rings per Engine	In/1000 Hours		Cylinder Deposits Clean=10	Exhaust Ports Percent Open	Carbon Hardness Soft=3	Crankcase Sludge Clean=10	Gear Wear None = 5	Bearing Wear Ins.	Neut. No. Inc. mgs. KOH/g.	IFT Dec. Dynes/cm.	Vis. Inc. SSU/100 F.
			Ring Gap Wear	Cylinder Wear									
A(1)	103.0	6.7	.0328	.0002	8.0	84.7	1	9.7	4.6	.0004	.06	1.4	29
B(1)	105.7	5.0	.0341	.0004	7.3	93.8	1	10.0	4.7	0	.03	1.0	15
C(1)	105.0	2.0	.0348	.0004	7.5	85.7	1	10.0	4.8	.0012	.17	.8	7
D(2)*	101.0	13.7	.0357	.0008	9.0	94.7	2.5	9.3	4.7	0	.11	1.1	13
D(2)**	95.5	8.7	.0227	.0006	8.3	94.2	2.5	8	4.8	0	.07	.3	10
E(2)	77.3	9.0	.0317	.0006	8.7	89.0	0	8.3	4.5	0	.42	0	24
F(2)	107.7	0	.1339	.0015	7.3	88.3	2	9	4.8	0	.13	3.5	33
G(3)	106.3	9.3	.0001	.0003	9.3	74.6	1	10	4.4	.0005	.02	.6	5
H(3)	96.8	9.5	.0197	.0011	6.5	93.8	1	10	4.5	0	.02	2.1	5
I(3)	93.0	8.0	.0054	.0005	8.5	67.9	1	9	4.8	0	.07	1.5	11
J(3)	88.0	11.0	.0245	.0004	8.7	83.6	.5	8	4.6	.0012	.27	3.6	25
K(4)	102.0	0	.6280	.0014	8.0	97.1	3	10	4.5	0	.02	2.9	0
L(4)	105.0	0	1.0340	.0017	9.0	95.7	3	10	4.7	0	0	5	70
M(4)	105.0	2	.6305	.0017	7.0	100.0	3	10	4.5	0	0	0	43

Table IX. Summary of results obtained from Lauson engine oil evaluation program; average figures for each one. Key: (1) Straight high-Viscosity Index paraffinic mineral oil; (2) Heavy-duty detergent mineral oil meeting U. S. Army Specification 2-104B; (3) Oxidation-inhibited high-Viscosity Index mineral oil; (4) Straight low-Viscosity Index naphthenic mineral oil; (*) Modified Continental Oil Co. oxidation test.

Oil	Test Hrs.	Over-all Weighted Piston Deposit Rating	Bearing Wt. Loss Rating mgs.	Crankcase Sludge Rating	Piston Ring Rating	Oil Oxidation at 115C. Hrs.*	Increase in		Percent Increase in Vis.	Chloroform Insol.	Naphtha Insol.	Chloroform Sol. of Naptha Insol., Percent	Final Union Color Dil. 1/40	Percent Dec in IFT
							Neut. No. mgs.KOH/g. oil	Sap. No. mgs.KOH/g. oil						
A(1)	60	112	199.5	9	9	14.5	2.13	11.6	13	.15	.18	57.9	5	40
A	240	105.5	50.4	9	8		.42	2.9	18	.12	.15	46.6	2 ½-3	29
B(1)	60	110.5	424.2	8.5	9	12	1.19	15.3	53	.18	.22	43		47
B	240	101.5	34.2	7	8		.77	5.8	37	.14	.17	36.9	2-2½	51
C(1)	60	107.5	112.2	9	9	16	1.93	12.2	25	.09	.22	74.5	4 ½-5	68
C	240	99.5	100.6	8	8.5		.97	13.8	21	.08	.14	38.4	3-3½	62
D(2)	60	113.2	54.6	8.5	8.5	54			26	.54	.60	34.6	2-3	
D	240	107.5	6.6	9	8				27.1	.30	.35	32.8	1 ½-2	
E(2)	60	119.0	5.1	9	9	24			16	.45	.50	59.6	3-3½	
E	240	116.5	10.2	8	9				13.1	.33	.45	52.5	2½ -3	
F(2)	60	97.5	3.2	7.5	8.5	49			43.3	.26	.67	70.6	5	
F	240	100.7	13.9	7.5	8.5				37.5	.32	.44	45.2	3	
G(3)	60	118.5	18	8	8.5	111	.4	4.1	2	.20	.30	36.7	2½ - 3	29
G	240	98.2	15.3	9	5		0	3.1	6	.15	.22	47.9	1-1½	31
H(3)	60	121.5	751.6	9	8	168	5.4	18.3	39	.23	.21	44.5	3½ -4	49
H	240	101	23.4	9	8		.7	2.9	5	.07	.28	50.5	1-1½	47
I(3)	60	110.2	8.2	8.5	8	39.5	1.0	3.1	6	.23	.25	57.5	3	22
I	240	98.7	60.1	8	6.5		.5	3.2	8	.11	.15	76.1	2½ -3	32
J(3)	60	120.5	180.5	8	9	30	1.4	6.8	18	.20	.15	49.9	4½ -5	29
J	240	118.7	20.1	9	8.5		.7	3.5	19	.19	.14	23.8	3	18
K(4)	60	94.7	10.7	4.5	8	6.5	2.53	13.9	148	.09	1.34	94	6	53
K	240	84.5	6.4	7	7.5		.85	6.6	86	.12	.56	72	3½	49
L(4)	60	110.5	10.6	6	9	15	1.55	9.5	34	.02	.24	69	3½ -4	57
L	240	97.5	3.4	8	9		.93	5.2	33	.03	.38	62	2½ -3	49
M(4)	60	107.5	10.4	3	8.5	14	2.13	13.7	100	0	1.16	89	5-6	38
M	240	93.0	38.9	7	7		.45	5.1	55	.05	.15	70	2 ½	37

some heavy-duty detergent oils. Very little additive depletion was observed with this oil using activated alumina by-pass filter maintenance. In fact, the test with this oil using activated alumina maintenance received a higher test rating than the test with this oil maintained with cellulose waste filters.

(8) Upper-cylinder lubrication appears to be the most critical factor affecting the lubrication of the radial gas engines. Carbon deposition is second in importance.

SPECIFICATIONS & QUALIFICATION TESTS FOR NEW OILS. On the basis of the results of this oil evaluation program, the following tentative specifications have been set up for the aid of the Purchasing Department for oils to be used in the lubrication of both the eleven- and twelve-cylinder radial gas engines:

(1) A representative sample of the oil must meet or exceed the following requirements: (a) Viscosity SSU/100 F.: 600 min., 790 max.; (b) Vis-

cosity SSU/210 F.: 65 min.; (c) Viscosity Index: 80 min.; (d) Flash Point, °F.: 390 min.; (e) Pour Point, °F.: 10 max.; (f) Foaming Test/75 F.: Oils must have less than 10 ml. of foam after 5 minutes aerating; (g) Alcoa modified Continental Oil Company oxidation stability test at 115 C.: 10 hrs. minimum.

(2) This specification is not intended to preclude oxidation-inhibited oils, but also does not specify their use.

(3) Any products meeting these specifications are subject to confirming operating tests before final approval.

At the present time, new oils submitted to the Purchasing Department for possible qualification for use in the radial gas engines are handled as follows:

1. Preliminary laboratory inspection.
2. Full-scale engine test for three to six months in one engine.
3. No oil will receive final approval until it has passed at least 6000 hours satisfactory service in three engines.

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ACKNOWLEDGEMENT. The contributions of the following people in this program are acknowledged: Messrs. D. H. Perry, L. O. Ray, J. M. Smith, T. O. English, D. I. Bohn, J. T. Bunting, and E. B. Colley.

Section News

Connecticut Section Past-Chairmen Honored (March meeting). Pictured from left to right: D. H. VanVleck, Cuno Engineering Corp.; A. F. Green, The Farval Corp.; C. R. Gillette, New Departure Div., GMC; and F. M. Dohl, Dee Engineering Co.

CHICAGO, March meeting. L. J. Reguly, Senior Mechanical Engineer for Inland Steel Co., presented a paper entitled "Steel Mill Lubrication." (Submitted by J. N. Waddell, Sec'y-Treas.)

CONNECTICUT, March meeting. "Past-Chairmen's Night," honoring F. M. Dohl (Dee Engineering Co.), C. R. Gillette (New Departure Div., GMC), A. F. Green (The Farval Corp.), A. K. Hoge (New Departure Div., GMC), J. F. Martin (F. E. Anderson Oil Co.), C. A. Pethybridge (New Britain Machine Co.), F. E. Stockwell (Esso Standard Oil Co.), and D. H. VanVleck (Cuno Engineering Corp.); preceded by Election of Officers (see ASLE Directory), and followed by a paper presented by S. E. Pond, Project Engineer for Pratt & Whitney Aircraft Div., entitled "Criteria & Instrumentation in Focus on Oil Problems Today." (Submitted by A. E. VanSchoick, Publicity Chrmn.)

MILWAUKEE, March meeting. G. E. Evans, Technical Director for Penola Oil Co., presented a paper entitled "Modern Motor Oils," covering such topics as: multi-range motor oils, oil consumption, oxidation inhibitors, sticky valves, sludge, hi-viscosity index, and "Why Change Oils?" (Submitted by J. H. Berg, Sec'y.)

MONTREAL, October '55 meeting. D. F. Wilcock, Manager of the Chemical Process Dept., General Electric Co., presented a paper entitled "Prediction of High-Speed Journal Bearing Performances."

November '55. "Significance of Additives in Lubricating Greases," by R. N. Smith, Supervisor of the Technical Div., McColl Frontenac Oil Co.

December '55. "Railroad Diesel Lubrication," by J. W. Ussher, Lubrication Engineer for Canadian Pacific Railway Co.

January. "Centralized Lubrication," by J. J. Jenkins, Chief Engineer for Lincoln Engineering Co.

February. "Oil Seals, Gaskets & Mechanical Packings," by C. E. Schmitz (ASLE Past-President), Vice-President of Crane Packing Co.

March. "Oil Purification," by B. Kahane, Engineer for The DeLaval Co., Ltd.

April. "Lubricating Oil Refining," by A. B. Anglin, Supervisor for British American Oil Co., Ltd.

May. "Hydraulic Fluids," by C. E. Pope (ASLE Past-President), Chief Lubrication Engineer for Eastman Kodak Co. (Submitted by J. H. Whyte, Sec'y.)

NEW YORK, February meeting. "Ladies' Night," featuring Miss Hazel Bishop who spoke on the subject "Chemistry & Use of Cosmetics."

March. C. M. Finlayson, Eastern Representative for Baroid Div., National Lead Co., presented a paper entitled "Special-Purpose Greases," explaining the general characteristics and performance advantages of Bentonite in comparison with the usual soap-containing greases. (Submitted by E. Landau, Publicity Chrmn.)

N. CALIFORNIA, March meeting. J. P. Critchlow, Gulf Oil Corp., presented a paper entitled "Gear Lubrication in the Steel Industry," covering the design and development of various types of gear teeth, some of the theories of gear lubrication, the mechanisms of oil film formation, and

(Continued on p. 208)

The Spray & Drip Methods Of Applying Lubricant To Wire Rope

by D. B. Burroughs*

In recent years more and more wire rope users in many fields have become aware of the increased safety and operating benefits gained by lubricating wire rope in service. The development of new and improved lubricants has enabled users to get effective rope lubrication by the relatively easy spray and drip methods of application. At the present time a number of major wire rope installations use either of these methods for semi-automatic or completely automatic lubrication of wire rope. Mine hoists, elevators, tramways, and earth moving equipment are just a few such installations. Lubricants with widely-varying characteristics have done much to make the spray and drip methods adaptable for use on most types of equipment. Additives that give lubricant special properties have proven of great value in facilitating application as well as improving rope service.

Before attempting a discussion of the spray and drip methods of lubricating wire rope, it seems desirable first to have a foundation of several basic facts concerning the lubrication of wire rope.

One of the prime purposes of lubrication is to assure maximum safety throughout a rope's service life; i.e., to save human lives, by preventing corrosion and internal deterioration in wire rope which cannot be accurately evaluated by external inspection. This consideration is of the utmost importance on such installations as mine hoists and elevators. Another prime purpose of lubrication is the saving of time and money in the maintenance and replacement of not only the wire rope itself, but also the drums, sheaves, and other equipment concerned with a rope's operation. In many instances it is not possible to build into a rope all the lubrication it will ever need during its entire service life. Wire rope manufacturers would like to be able to make such a guarantee, but it is not anymore possible for them to do this than it would be for an automobile manufacturer to guarantee that his product will never need any additional lubrication during its normal service life. The strands and core of most ropes today are stuffed during fabrication with as much lubricant as they can retain, but during service a portion of the original lubricant oozes out due to heat or heavy radial pressures and is wiped away by abrasion and the washing action of rain and other elements. The cases are relatively few in number where a user can assume there is absolutely nothing to be gained by lubricating his wire rope in service.

*John A. Roebling's Sons Corp., Wire Rope Engineering Div., Trenton, N. J.

(This paper was presented at the ASLE 11th Annual Meeting, Pittsburgh, April 4, 1956.)

In recent years more and more wire rope users have become aware of the economies gained by lubricating wire rope in service. This has been the outgrowth of several conditions. Diminishing profits from highly competitive conditions have forced users in many different fields to find ways of cutting their costs, and cheaper and more effective lubrication of their equipment has been one means of accomplishing this end. Lubricant manufacturers have also been continually improving their products and developing new ones to the extent that the man in the field, at present, can obtain a lubricant to do almost any one or combination of jobs on his wire rope and other equipment. This situation of having lubricants available with widely varying characteristics, coupled with the growing desire of wire rope users to lubricate their ropes in an inexpensive and effective manner, has fostered the spray and drip methods of application.

Some years ago wire rope users were advised to apply a heavy-bodied lubricant, one that is not fluid at normal operating temperatures. This type of lubricant had to be heated at the job, and was generally brushed on or applied by pulling the rope through a heated trough of some type. In most cases the hot lubricant chilled quickly upon contact with a cold rope, forming a sheath or coating of heavy lubricant on the rope surface which prevented the loss of the original lubricant in the rope and kept external deteriorating agents from penetrating the rope. This method was effective only as long as the seal formed by the external coat of lubricant remained unbroken, and therein was its greatest disadvantage. In some cases the lubricant was not applied carefully or often enough to maintain the necessary seal, and internal corrosion and deterioration developed in ropes that externally appeared well lubricated and in good condition.

D. B. Burroughs

Nowadays most wire rope manufacturers recommend making frequent applications of a light-bodied lubricant, one that is thin enough to penetrate into the strands and core of a rope and protect against internal corrosion, as well as to minimize internal friction between

component parts. Wire rope users generally prefer to apply a light-bodied lubricant by a drip or spray method, as compared to other methods such as by brushing it on by hand or by pulling a rope through a trough of some type. Usually the user can devise some type of drip or spray apparatus that will lubricate the rope in a semi-automatic or completely automatic manner. It has been said that a good engineer is a lazy engineer, because you can be assured he will devise a machine that will do the job and require the least amount of effort from the man. In most instances this is the case with the type of apparatus used for spray and drip applicators. When a master mechanic comes across a suitable lubricant that will effect some operating economies, he will naturally set about devising some means of applying the lubricant in an easy, automatic manner. It has been our experience that he will almost invariably settle on some form of the spray or drip methods of application if either of the methods is workable.

These methods require placing one or more sources of lubricant at locations where most or all the rope is accessible. The lubricant, of necessity, must be fluid enough to flow from the reservoir through the delivery system to the rope. This does not present any problem for a light-bodied lubricant; however, a heavy-bodied lubricant, one that is not fluid enough to be applied under the existing conditions, can generally be made suitable for use by adding a solvent which will thin out the lubricant to the desired degree. In some cases the addition can be made at the supplier's plant during manufacture to meet certain specifications. The solvent can also be added by the user at the installation. This gives the user a certain amount of flexibility, in that he can vary the consistency of the lubricant to suit his individual needs. For example, changing temperature and weather conditions might make it advantageous to be able to vary the consistency in order to get a certain degree of fluidity and penetration.

The spray and drip methods are identical in that they both require a reservoir, a delivery system of hose or tubing, and some type of orifice, valve, or nozzle to control the amount and direction of lubricant dispensed. If the lubricant is mixed with air under pressure to form a mist or vapor, this constitutes a spray system. If the lubricant is applied directly without mixing with air, then it is a drip system.

For example, a simple lubricator might consist of a container of lubricant located directly above a moving rope that has some type of drip valve for controlling the rate and direction of the flow of lubricant. It makes no difference whether the lubricant comes out slowly drop by drop or in a steady stream. This would still constitute a drip system. However, if some type of spray valve or nozzle that mixes air with the lubricant is used instead of a drip valve, then this would be considered a spray system. A great many of the drip and spray equipment today are nothing but advanced versions of this fundamental scheme. In some cases the reservoir is located above the rope so that gravity supplies the force to deliver the lubricant to the rope. In other cases a pump or air pressure is used to force lubricant through the delivery system to the rope.

There is one vertical shaft mine that uses the drip method for lubricating the hoist rope at the head sheave. A force-feed oil pump, attached to the storage tank, is driven by a linkage arrangement connected with the shaft of the head sheave at the top of the head frame. Whenever the hoist is put in operation, the rotating shaft drives the pump which, in turn, delivers lubricant to the rope. This system is fully automatic except for refilling the reservoir, and no lubricant is wasted since the lubricant is applied only while the hoist is in operation.

In the case of a coal company, one of the main factors responsible for the recent increase in the life of the 2⅜" dia. hoist ropes used on their 46-yard shovels was the use of a light lubricating oil applied by a recently-developed spray system.[1] The apparatus is essentially ". . . a pressure-greasing system that was converted to oil. Booms are piped and oil is delivered at 1,000 psi to an accumulator mounted over the point sheaves. From the accumulator, oil goes to a solenoid valve actuated by a timing mechanism. The timing mechanism, in turn, is controlled by the lowering time of the bucket. The actual delivery of oil is done through an atomizing nozzle." For lubricant they finally settled on a light-bodied lubricating oil having a 100-second viscosity at 100 degrees and a pour point of minus 20 degrees F.

There is another mining concern which uses a rather unusual type nozzle. It is a pipe bent in a helical shape somewhat resembling a pigtail. Small holes are drilled around the inside diameter that direct the flow of lubricant toward the center of the helix much like a shower nozzle. This pipe is easily fitted around the rope, and a rope length can be lubricated either by having the nozzle stationary and moving the rope, or by moving the lubricator along a stationary rope. A portable tank of lubricant fitted with a valve for mixing air with the oil and connected to a 100 psi air line, comprises the rest of this spray apparatus.

Similar spray- and drip-type applicators for lubricating wire rope have been successfully used on elevators, lift bridge towers, cableway carriages, and other types of earth moving and mining equipment. For example, "Red Dust" or "Red Rouge" are terms used to describe a condition that develops in some elevator hoist ropes. It is the result of abrasion between the fiber core and the steel wires of the strands where they contact each other inside the rope. The abrasive condition starts when the core reaches a state of dryness due to the original lubricant being squeezed out during the rope's operation over sheaves. Minute particles are worn from the steel wires which oxidize, and become red-colored dust which is soon noted in the valleys between the strands. After this condition starts the action accelerates, because the dust itself acts as a polishing medium and wears further particles from the wires.

Although the amount of metal worn away in this manner is not usually significant, the fact that the fiber core is dry enough to abrade the steel is an indication that the core is drier than it should be and is liable to deteriorate excessively in the not-too-distant future. Lubrication with a light-bodied oil that will penetrate into the strands and core is essential, in order to preserve the sisal fibers and prevent the development of more dust. Several suitable lubricants have been formulated by lubricant manufacturers and elevator companies to minimize this condition, and also devices for applying them have been developed. One such applicator allows lubricant to drip from a reservoir at a certain rate onto two sets of brushes which spread it over the entire surface of the ropes. This is a modified drip applicator which does an effective, cheap job.

As mentioned previously, any lubricant used in these systems must be fluid enough to flow through the apparatus. It makes no difference whether the required fluidity is characteristic of the lubricant or is obtained by use of a thinner. Some thinners are permanent, while others are volatile and will evaporate in time leaving a residue of heavier-bodied lubricant. A volatile-type thinner is particularly useful for applying heavy-bodied lubricant by the spray or drip method when a coating of thick lubricant on the surface of the rope is desired. When good penetration of the strands and core is desired by one or more applications of lubricant, it is best to use a permanent-type thinner, such as a very low-viscosity lubricating oil. Another type additive deserving mention is the polar-type corrosion inhibitor which gives lubricant greater affinity for steel. These compounds have done much to increase the effectiveness of lubricants in combating corrosion. All such additives should be completely miscible with the lubricant, and be free of any compounds capable of adversely affecting the steel wires or sisal core fibers of a wire rope.

In summary, frequent application of a suitable light-bodied wire rope lubricant is advocated today by most wire rope manufacturers as being the most effective manner of lubricating ropes that operate around sheaves and on drums. A light-bodied lubricant can definitely penetrate wire rope. This was proven by the results obtained in a series of tests made by Roebling.[2] The fact that light-bodied lubricants can do such a good job of lubricating operating ropes, and are also ideal for use in spray and drip-type applicators, makes this combination seem increasingly important to wire rope users interested in maintaining maximum safety and in cutting costs.

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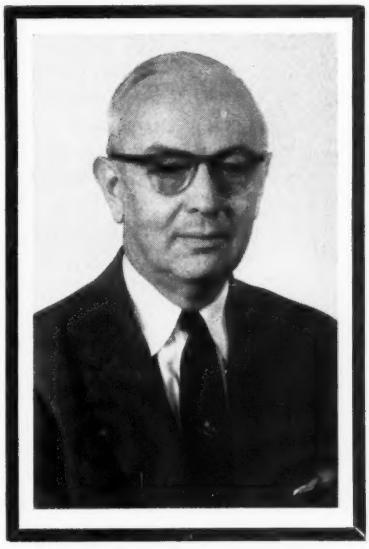
In Memorium



L. WILBUR "WIB" DEUTSCH

The American Society of Lubrication Engineers regrets to announce the sudden death of their newly-elected President, Mr. L. W. Deutsch, on April 13. Wib Deutsch studied at the Case Institute of Technology, Cleveland, Ohio, majoring in mechanical engineering. He was employed by the Empire Brass Co., and became plant manager and, later, secretary of the company. In 1936 he joined Trabon Engineering Corporation as sales engineer and superintendent of construction. In 1940 he was transferred to Pittsburgh as district representative, and later to San Francisco. In 1948 he became General Sales Manager of Trabon, retaining this position until 1956 when he joined the Aro Equipment Corporation of Bryan, Ohio, as Sales Manager of the Industrial Lubricating Equipment Division.

Besides the activities in ASLE, Mr. Deutsch had attained the 32nd degree Masonic order and was active in the Shrine Patrol, serving as its captain for a number of years.

Native to Cleveland, he had not yet moved to Bryan, Ohio, when death, attributed to leukemia, struck. He is survived by a wife, two sons, and a sister.

Wib Deutsch helped form the American Society of Lubrication Engineers in 1944. He was an industrial member, and in 1952 was elected to the Board of Directors. In 1955 he became the Vice-President at Large. At the recent Annual Meeting he was elected President of the Society. He was 54 years old.

The Disposal Of Soluble Oil Wastes

by E. E. McClung*

The disposal of soluble oil wastes is covered by Federal, state, municipal and other laws and regulations. As industry expands, the amount of industrial wastes will increase and the controls will become more rigid. Before disposal of wastes into state waters, and this includes soluble oil wastes, state laws require that permits must be obtained from the appropriate state regulatory body. The permits stipulate in parts per million the maximum amount of oil allowable in the final water from split soluble oil waste, if such water enters state waters. The regulatory body issuing the permits usually has the authority to set these maximum amounts according to the volumes of soluble oil wastes and local conditions involved.

A description of one method is given, which uses aluminum sulfate for splitting and calcium hydroxide for clarification of the final waste water. This method is being used successfully by some industrial plants for their soluble oil waste disposal and is meeting permit requirements. Results are given of laboratory runs on three different types of soluble oils. These results have been confirmed by field tests, and indicate what may be expected from this method.

Increasing legislation against stream pollution is forcing more and more industries to face the question: "How can we dispose of soluble oil wastes more effectively?" The legislation is directed against industrial wastes in general, and in most cases soluble oil wastes are not specifically mentioned but are definitely included. Because the area is so large, the topic to be discussed in this paper will be limited to soluble oil wastes and a chemical method of splitting the waste emulsions so that the oil content may be removed for simplified disposal, and the water remaining will meet the regulations involved.

The laws and regulations concerning waste disposal include Federal, interstate, state, and municipal. The growing knowledge about wastes and the improved methods of disposal being developed are leading to more rigid enforcement, and industry will face greater responsibility as time goes on.

The purposes of these laws and regulations are, of course, to keep state, interstate, and coastal waters clean and unpolluted, suitable for normal human usage and non-injurious to wild and aquatic life. Some of the typical controls imposed are: (1) Federal, the Federal Water Pollution Control Act; (2) Interstate bodies, such as The Ohio Valley Sanitation Compact; (3) State laws and regulations; and (4) Municipal laws and regulations.

The Federal Water Pollution Control Act is intended to encourage uniform state water pollution control laws, to prepare water pollution programs in co-operation with other Federal, state and interstate agencies, to aid and assist the state and interstate agencies, and to prevent the pollution of inter-state waters by any state. The powers to effectuate the expressed purposes of the act are vested in the Surgeon General of the United States.

The Ohio Valley Sanitation Compact was negotiated by representatives of Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Tennessee, and West Virginia. It creates a regulatory commission similar to those created by the several states.

In general, states have Water Pollution Control Boards. These regulatory agencies are created by the legislatures for the purpose of preventing or abating pollution of state waters. All persons are prohibited from polluting any waters by the disposal of sewage or industrial wastes without first obtaining a permit from the regulatory agency. The agency has investigating and rule making powers, and it may exercise its discretion as to whether or not any particular type of pollution should be permitted. With a few possible exceptions, these state laws treat oils and chemicals the same as other substances comprising industrial wastes, so the discharge of oil into state waters without a permit would constitute unlawful pollution.

Since Municipal and local Sanitary District regulations may vary so greatly, specific comment can hardly be made. But they must be taken into account when disposing of soluble oil waste. For our present consideration, it is important to realize that state and some municipal laws require a permit for the disposal of industrial wastes, and this includes soluble oil waste. The appropriate agency will stipulate the amount of oil allowed in the final waste water.

Soluble oil wastes can be split by acids, acid salts, or by an excess of a neutral salt, such as common salt or sodium chloride. Of these, aluminum sulfate or filter alum is probably used more extensively. This has several advantages. It is inexpensive, readily soluble, and has a pH of approximately 3.3 when in solution. Aluminum sulfate reacts with the water-soluble emulsifying soaps to form water-insoluble but oil-soluble soaps. This causes the soluble oil wastes to split, and the oil rises to the

E. E. McClung

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(This paper was presented at the ASLE 11th Annual Meeting, Pittsburgh, April 6, 1956.)

surface. Still another advantage of aluminum sulfate is that when lime (calcium oxide or calcium hydroxide) is added to the water portion of the split emulsion, the lime reacts with the excess aluminum sulfate, forming a floc of aluminum hydroxide which settles, carrying with it nearly all of the residual oil remaining suspended in the water.

The following method is illustrated schematically in Fig. 1. The soluble oil waste is collected in a tapered-bottom tank equipped with a stirring or mixing mechanism. Aluminum sulfate, dissolved in water, is added in the amount of one-half ounce per gallon of the collected waste. The waste should then be well mixed for at least one hour. In experimental laboratory work it has been found essential to allow enough mixing time for satisfactory results. Experiment and experience have also shown that a considerable excess of aluminum sulfate must be present. One-half ounce per gallon will be enough to handle practically any situation.

The tank of split soluble oil waste is allowed to stand for 24 hours, and the split water portion is drawn from the bottom into another tapered-bottom tank for further treatment. There will probably be an oil-water rag between the water and the split oil. This rag can be drawn off and disposed of separately, or it may be added to another batch of waste to be split.

The top split oil is then drawn off and centrifuged to remove water. This oil has salvage value. It may be used as bunker oil, or it may be sold for reclaiming; some plants find it suitable to add to their line oil.

The water separated from the split soluble oil waste which has been drawn off into another tapered-bottom tank with a mixer, is now treated with a slurry of calcium hydroxide in water. One-fourth ounce of calcium hydroxide is used per gallon of the water from the soluble oil waste. This is now stirred for an hour and allowed to settle for 24 hours or more. The calcium hydroxide reacts with the aluminum sulfate, and throws down a flocky precipitate of aluminum hydroxide which carries with it practically all of the oil suspended in the water.

The sludge of aluminum hydroxide and calcium sulfate in the bottom of the tank is then drawn off. Usually sludge can be deposited in a pond or lagoon for drying and then disposed as solid material.

The water from the waste is now substantially free from oil and prohibited chemicals, and is generally suitable for disposal in a normal manner. However, it must pass the requirements of state and municipal authorities. If the oil content is still above authorized amounts, the waste water can be diluted with other water to bring it within allowable limits.

So far as we know, Pennsylvania is the only state which specifically mentions oil emulsions in its regulations. Permits for oil separators authorized by the Sanitary Water Board generally contain these stipulations: "The effluent from the oil separator shall at no time contain more than 30 parts per million of oil; also, if oil emulsions are discharged from the separator, it will be necessary . . . to break the emulsions by chemical or other means, or otherwise to prevent their discharge."

The other states' regulations usually consider oil wastes as a whole, and say that waste water flowing into state waters shall be substantially free from oil. This leaves the interpretation of the word "substantially" up to the enforcement agencies of the respective states. We have heard of allowable oil tolerances varying from 30 parts per million to 100 or more, depending on location and the amount of waste water. However, these generally are not fixed limits, and the permissible limit is usually set by the decision of the state or municipal regulatory bodies.

To show what might be expected when soluble oil wastes are split by this method, operations were conducted in our laboratory using three different types of soluble oils. The concentrations used were

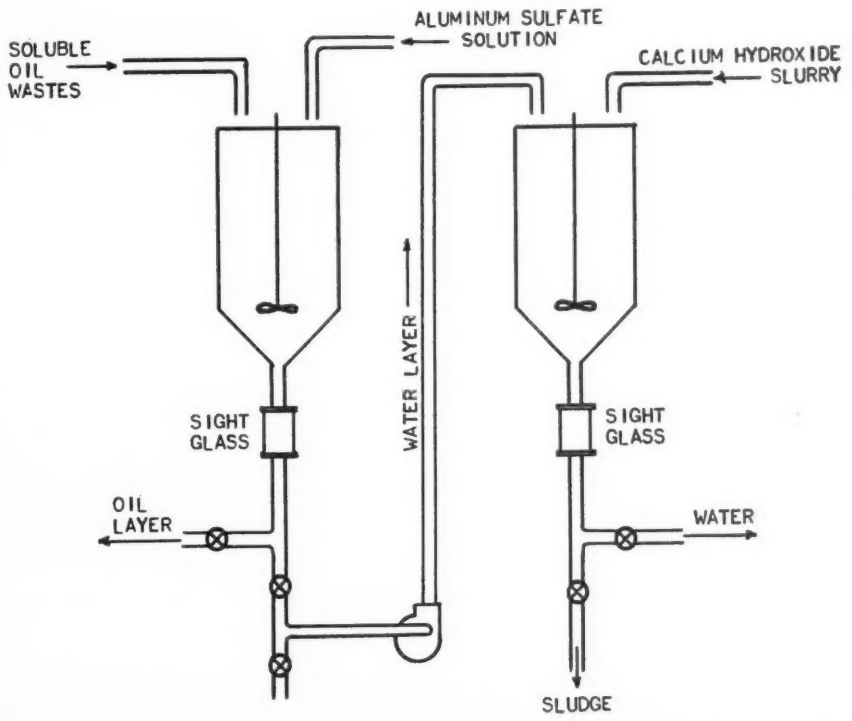

Fig. 1. Schematic diagram of method for treating waste emulsions.

Table I

Oil Content (ppm) of Split Water after Aluminum Sulfate Treatment

Standing Time	Oil "A"	Oil "B"	Oil "C"
12 hours	282	132	376
24 hours	254	130	334
48 hours	240	120	330
One week	114	96	300

Note: Oil "A" is a high-oil-content cutting compound; Oil "B" is a grinding compound with a semi-transparent emulsion; Oil "C" is a soluble oil exceptionally resistant to very hard water.

20 parts of water to one part of soluble oil, and the pH of these emulsions ranged from 7.5 to 9. After the addition of the aluminum sulfate, the pH was about 4 in each case. After the addition of the calcium hydroxide, the pH was slightly more than 9 in every case. Aluminum sulfate was used at one-half ounce per gallon, and calcium hydroxide was used at one-fourth ounce per gallon.

The oil content of the split waters at intervals of 12, 24, 48 hours and after one week, are shown in Table I. This is before the addition of the calcium hydroxide. One-fourth ounce per gallon of calcium hydroxide was added to a separate portion of the split water which had stood for 24 hours, and after standing another 24 hours the oil content was again determined. These results are presented in Table II.

As indicated, Oil "C" is exceptional, being formulated for extremely hard water. Actually, when one ounce of aluminum sulfate is used instead of a half-ounce, the oil content of the split water from Oil "C" is only 208 ppm at the end of 24 hours before the addition of calcium hydroxide.

These results indicate that by using both an aluminum sulfate and calcium hydroxide treatment, and allowing a 24-hour standing period after each treatment, the oil content of the split water is well below any requirements likely to be met. These results check closely with reports from various plants using this method.

When time permits and the split waste is allowed to stand longer, it is possible that in some cases aluminum sulfate treatment alone will meet requirements. If the oil content is still a little high, dilution with water will reduce it to permissible limits. The use of calcium hydroxide shortens the time considerably and leaves a smaller amount of oil in the water.

The quality and properties of the recovered split oil will depend on the types of oils used in the original soluble oils. In addition, other oils such as

Table II

Oil Content (ppm) of Split Water after both Aluminum Sulfate & Calcium Hydroxide Treatment

Standing Time	Oil "A"	Oil "B"	Oil "C"
24 hours after Aluminum Sulfate treatment	254	130	334
24 hours after subsequent Calcium Hydroxide treatment	28	26	40

spindle oil and hydraulic oil most likely will be present. Samples of oil recovered by several industrial plants showed only traces of water and no mineral acidity. Flash Points ranged from 300 to 340 degrees F., and Viscosities from 130 to 150 seconds. The oils contained aluminum soaps, and an aluminum oxide ash as high as 0.5% has been observed.

Fortunately, the necessary expense involved in the disposal of soluble oil wastes can be reduced by utilizing the salvaged oil in the most efficient manner, and when high-quality, long-lasting soluble oils are used that are most suited to the work, there will be a very definite decrease in the amount of soluble oil waste to be treated.

Since time, space, and available equipment vary widely in industrial plants, modifications of the method described may be desirable or necessary. For example, the split water may be filtered or centrifuged to remove the aluminum hydroxide floc containing the residual oil. This will save considerable time, and will give a more compact residue that may be disposed more readily. Sometimes, through necessity, the complete splitting operation has been done in one tank, possibly at the cost of recovering a clean oil.

Occasionally, the disposal of soluble oil wastes is tied in with the disposal of other plant wastes in such a way that some other method of splitting, such as by acid or calcium chloride, might be used to advantage. This is a problem for the plant engineers and chemists working with the state and local authorities.

The day is passing or has already passed when soluble oil wastes can simply be dumped in the sewer. Restrictive laws and regulations require that these wastes be treated so that the residual oil content is within low permissible limits. In general, the state regulations are especially important and are strictly enforced. Permits must be obtained for the disposal of wastes in state waters, and the permits will stipulate the amounts and types of waste permitted. The aluminum sulfate method of splitting soluble oil wastes is one of the methods now in use which has met the enforced restrictions.

Plan to Attend!

ASME-ASLE Joint Lubrication Conference

Chalfonte-Haddon Hall, Atlantic City, N. J., Oct. 8-9-10, 1956

A Tapping Test For Evaluating Cutting Fluids

by C. D. Flemming & L. H. Sudholz*

This paper describes a tapping test that is being used to evaluate cutting fluids, including both cutting oils and soluble oil emulsions. The equipment, conditions, and procedure for conducting the test are outlined, and typical results obtained with both oils and emulsions are presented. The correlation of this test with actual field performance is discussed, as well as the limitations of the test.

For many years much time and effort have been spent in an attempt to develop a simple bench test which would provide a means of predicting the performance of a cutting fluid under service conditions. A number of the extreme-pressure testers have been investigated for this purpose by individuals as well as by organized groups of technical societies. Much useful information has been obtained from these tests; however, actual metal cutting operations have proved more accurate.

At the cutting edge of the tool there are high-temperature, high-pressure, stressed metal and a newly-formed "nascent" surface. While bench tests may reproduce the first three of these conditions to some degree, the fourth condition — a nascent surface — can be obtained only by metal cutting. Hence, a metal cutting test was preferred by the authors.

Many test procedures have been developed employing metal cutting operations. While turning tests have been most widely used, others have been based upon drilling, threading, and tapping. The tapping operation was chosen for the test described in this paper because it fulfilled the following requirements: (1) simplicity, (2) speed, (3) economy, (4) small test sample, (5) precision, (6) correlation with field results, and (7) severe conditions.

Furthermore, the tapping test has a wide field of use. It is suitable for the evaluation of both non-soluble and soluble cutting fluids, as well as certain drawing compounds. It is also an excellent tool in development programs where anti-weld and oiliness additives are investigated.

The torques developed during the tapping operations were investigated quite thoroughly in 1936 at the Iowa Engineering Experiment Station. This study was concerned chiefly with the effect of cutting speed, thread depth, and metal.[1] More recently the factors affecting tapping torque were investigated by A. J. Carruthers.[2] While both studies included work on cutting fluid evaluation, this was not the main objective. Since tap life tests would require extended periods of time, they were not adopted in the test development work discussed in the present paper. Instead, torque measurements were employed to determine the relative tapping efficiencies of cutting fluids when compared with an arbitrary standard. In general, the laboratory data so obtained have correlated well with tool life under field service conditions.

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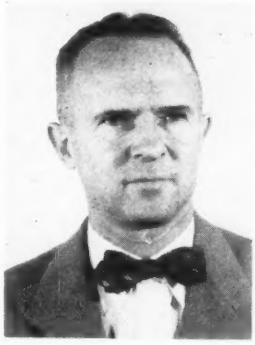
(This paper was presented at the ASLE 11th Annual Meeting, Pittsburgh, April 5, 1956.)

TEST EQUIPMENT. Briefly, this comprises a small drill press equipped with a floating table. The maximum force during tapping under standardized conditions is indicated on a scale by means of a torque arm mechanism. Figs. 1 & 2 are photographs of this machine. A detailed description is given in Table I.

A very sensitive spring scale is used to measure the torque. Some investigators have used strain gauges for this purpose. However, experience has shown that the greater sensitivity of the strain gauges has often been overshadowed by the variable introduced by the non-uniformity of the metal.

SAE 1020 hot rolled, having a Brinell hardness number (Bhn) of approximately 120, was selected as the test metal, since the tapping of this and similar soft, draggy steels was considered a difficult operation. Furthermore, it proved to be most sensitive to differences in performance characteristics of the cutting fluids, and minimized tap wear and breakage. Subsequent investigation of other metals, such as the higher carbon steels, SAE 1045, 180 Bhn, and the harder, clean cutting alloys including heat treated SAE 3140 steel, 280 Bhn, showed that they were inadequate in these respects.



C. D. Flemming

L. H. Sudholz

Table I. Test equipment.

Drill Press	17" Floor Model
Tapping Head	High Speed 5/16" capacity, friction clutch
Scale	15" Diam., 6 lb. capacity, 30 divisions
Taps	1/4 - 20 NC Plug, HSS Precision Ground
Test Metal	SAE 1020 HR flats 3/8" thick, 120 Bhn
Feed Mechanism	Constant pressure, spring loaded

For a workpiece, a 12" x 2" x 3/8" flat was chosen for ease of handling. Through holes were used to minimize tap breakage and chip binding. It was found that the thickness of the test piece should be 3/8" to assure the development of maximum torque.

Use of precision ground taps rather than the commercial grade is effective in minimizing erratic torque values. Taps consisting of high-speed steel instead of carbon steel are employed to reduce breakage and insure greater uniformity of results.

A semi-automatic feed mechanism is used to eliminate the variable vertical pressure which often exists when the tap is hand-fed into the hole. This device provides a constant load on the tap through a pre-compressed spring.

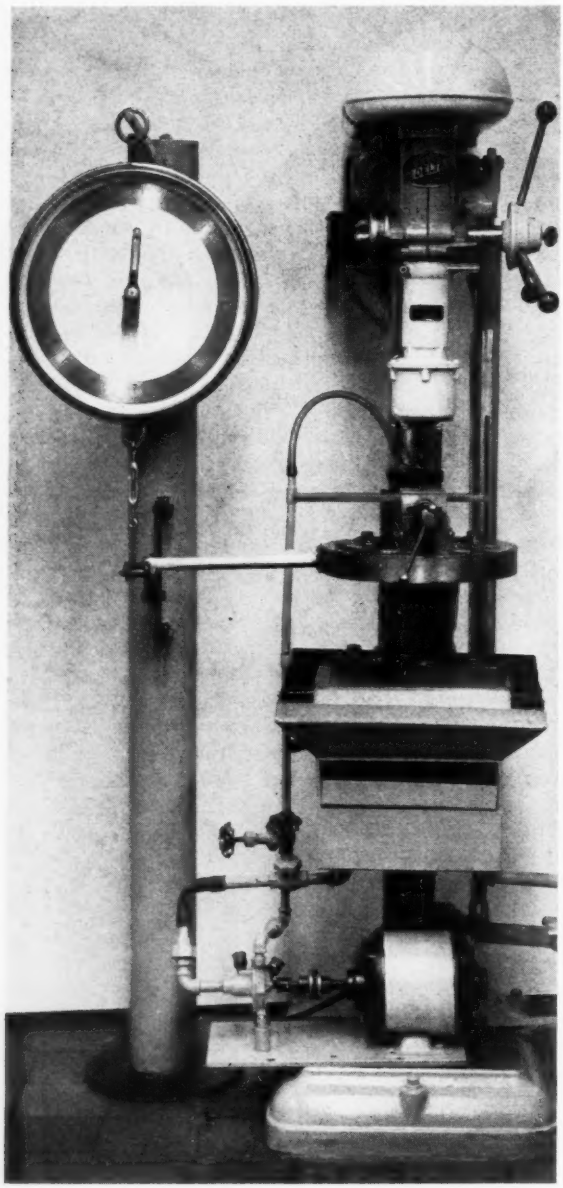


Fig. 1. Tapping tester.

Table II. Test conditions.

Tapping Speed	25 sfm
Hole Diameter	7/32" ± 0.0005"
Depth of Thread	48%
Cutting Fluid Flow	1/6 gpm (circulating)
Sample Size	1/2 gallon (minimum)

TEST CONDITIONS. Table II lists the test conditions which were found most favorable. While various tapping speeds were investigated, 25 sfm was finally selected as the most suitable, since it approximates commercial practice, and is sufficiently sensitive for cutting fluid evaluations. A thread depth of 48% proved to be the most desirable, because its use resulted in minimum tap wear and breakage and gave good precision. A continuous flow of 1/6 gpm of coolant, directed so that it would contact the tap at the top of the hole, was found to be satisfactory.

TEST PROCEDURE. Before performing the actual tapping operation, the holes are drilled in the test metal to a tolerance of ±0.0005". This precision is desirable in order to insure accurate results. Three drills and a final reamer are used for this purpose.

The test piece with the holes is clamped in a vise which is attached to the dynamometer table. Six holes are then tapped with each of five taps, making a total of 30 holes for the evaluation. The

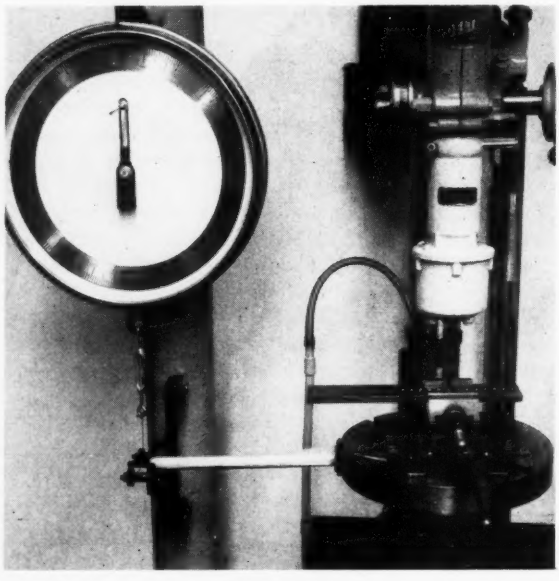


Fig. 2. Dynamometer, linkage and recording scale for tapping tester.

Table III. Typical variation in results. Key: (*) Non-soluble oils.

Product *	Tapping Efficiency, % (Individual Runs)	Tapping Efficiency, Reported %
Oil 1	94	93
	92	
Oil 2	96	96
	96	
Oil 3	93	
	97	95
	94	
Oil 4	80	
	87	
	84	84
Oil 5	93	
	85	89
	89	

Table IV. Typical test results with non-soluble oils.

Product	Tapping Efficiency, %
150" Paraffin Oil	60 (Barely Taps)
Non-Corrosive Sulfurized Oil	80
Moderately Sulfurized Mineral Oil	90
Drastically Sulfurized Mineral Oil	93
Heavy Duty Product	105
Standard Reference Oil	100

Table V. Typical test results with soluble oils. Key: (*) Evaluations on 1-15 emulsions.

Product*	Tapping Efficiency, %
Water	60 (Barely Tap)
Conventional Type	83
Heavy Duty Type (Sulfurized)	100
Heavy Duty Type (Chlorinated)	99
Standard Reference Oil	100

maximum torque developed during tapping of each hole is indicated on the scale. After an unknown oil has been evaluated in this manner, the procedure is repeated with a known oil which is used as a standard.

The tapping efficiency of an oil is defined by the following formula: Efficiency, % = (Torque with Standard Reference Fluid)/(Torque with Unknown Fluid) × 100. The torque value for each oil is the average of the maximum torques recorded during the tapping of the 30 holes. In calculating the efficiency of an unknown oil, the efficiency of the standard is arbitrarily assigned a value of 100%. Sample calculation: (68.2 in.lbs.)/(72.0 in.lbs.) × 100 = 95%.

Scheme of Evaluation. In the evaluation of a series of oils, the standard is run first, followed by four unknown oils. Then a run on the standard is repeated. If there has been a change in the torque reading for the standard, due to wear on the tap or variations in metal, this change is taken into consideration in calculating the efficiency of the unknown oils. In cases where key products are to be evaluated, duplicate or even triplicate runs are made, but not consecutively. In other words, the accuracy is improved by interposing other products between evaluations of the key product. This practice eliminates the chance of the key product being evaluated on a single piece of test metal which might have abnormal machining properties.

Taps are no longer used when visual inspection, made periodically, reveals slight wear or crushing of the teeth. When taps become badly worn, they all give about the same torque readings. Use of these values gives erroneous results. Normally about 100 oils can be evaluated before the taps have to be discarded.

Precision of Results. In nearly all cases at least two complete (30 hole) tests are run in evaluating a product. If the efficiencies of the first two evaluations are within 2% of each other, no further work is done. If the spread is greater, another evaluation is performed and the average of the three efficiencies is reported. Agreement between operators is usually within 3%. Table III shows the typical variations experienced during the evaluation of a series of oils.

STANDARD REFERENCE FLUIDS. Two standard reference fluids are used in evaluations. When non-soluble oils are being tested, an oil of that type is used as a standard. An emulsion (1 part oil and 15 parts water) of a heavy-duty soluble oil is used with products of the emulsifiable type. This practice is followed because it facilitates cleaning the coolant system between evaluations. Special cleaning procedures are necessary when a non-soluble oil is installed following the evaluation of a water soluble product.

TYPICAL TEST RESULTS. Tables IV & V show the typical results obtained with various products of both the non-soluble and water soluble types.

Non-Soluble Oils. Using straight mineral oil there is considerable welding, and only about one-half of the holes can be tapped through. Use of a non-corrosive, sulfurized oil relieves sticking of the taps. As the quantity of active sulfur is increased, the tapping efficiency improves, due to the decreased welding.

Soluble Oils. In the case of water, either the cooling property, the lubricating property, or both, makes it possible to tap nearly half of the holes. Emulsions of conventional soluble oils, which are basically blends of mineral oils and emulsifiers, give quite satisfactory results (about 83%). However, high efficiencies are obtained only with the heavy-duty types which contain EP additives.

The curves shown in Fig. 3 illustrate how the tapping efficiency of soluble oil emulsions decreases as the dilution with water increases. This is true for both conventional and heavy-duty types. Within a certain range, the same tapping efficiency is obtained with a dilute emulsion of a heavy-duty product and a rich emulsion of the conventional

Table VI. Effect of fatty oil.

Product	Tapping Efficiency, %
150" Paraffin Oil	60
Lard Oil	90
Sulfurized Mineral Oil	90
Sulfurized Mineral Oil + 20% Lard Oil	95

type. However, there are limitations to the degree of dilution. Emulsions which are too lean cause rusting, while rich emulsions (1-4 or less) show tendencies toward inversion.

EFFECT OF ACTIVE SULFUR. The test has proved useful in measuring the effect of antiweld materials in non-soluble oils. Fig. 4 shows that as the active sulfur content of a certain sulfurized mineral oil is increased, up to about 1.5%, the tapping efficiency increases. Active sulfur may be defined as that portion of the sulfur which can be removed from an oil by contacting it with copper powder for one hour at 300 F.

EFFECT OF OILINESS PROPERTIES. Table VI shows that the effect of fatty oils can be evaluated with the test. Lard oil gives good performance (90%), whereas a mineral oil is quite ineffective. The addition of lard oil to sulfurized mineral oil results in improved performance.

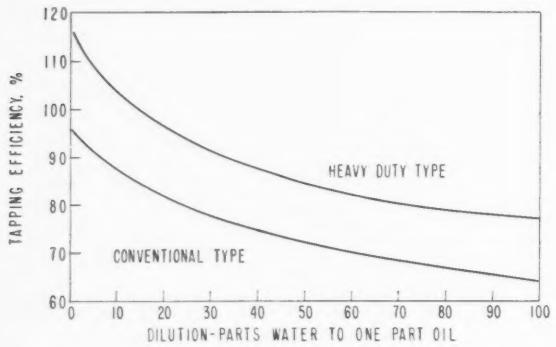


Fig. 3. Tapping Efficiency vs Soluble Oil Dilution.

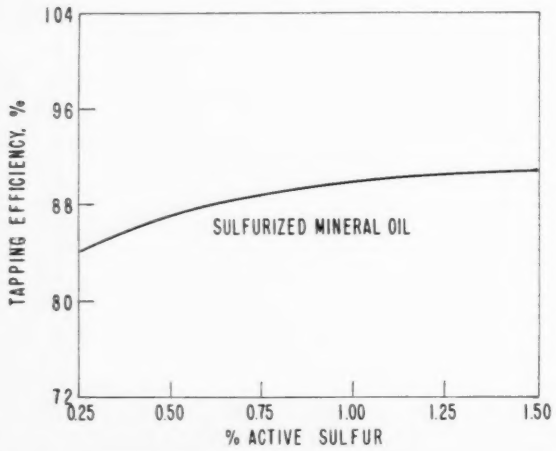


Fig. 4. Tapping Efficiency vs Active Sulfur.

Fig. 5 shows that as the concentration of a certain synthetic additive is increased in a corrosive type of cutting oil, the tapping efficiency improves. The optimum additive concentration is about 5%.

CORRELATION WITH FIELD PERFORMANCE. Over a period of years, products which gave high tapping efficiency generally showed superior tool life and finish in the field. However, in using laboratory data to predict actual performance, consideration must be given to the type of operation and the metal concerned. Correlation has been best in severe operations such as threading and broaching of soft, draggy metals.

Correlation was excellent in the case where various oiliness additives were evaluated for use in corrosive cutting oils. In another instance, wax additives were found to be inadequate in our tapping test. Field experience showed that on soft, draggy metals they were definitely inferior to sulfurized mineral oils.

Other operations, where correlation with tapping results has been good, are pipe threading and certain types of drawing. In one nipple threading job, guidance was obtained in formulating a product which gave good results when welding and finish were of prime importance. Tapping tests on both SAE 1020 steel and a jet alloy showed that oils having high anti-weld properties were required. This was borne out by field experience. The tapping test was helpful in predicting the value of drawing lubricants, especially where steel cartridge cases were concerned.

LIMITATIONS OF THE TEST. Some care should be exercised in using tapping data to predict performance in general. In the first place, type of metal has to be considered. While the tapping test has been especially useful in measuring performance on soft, draggy steels, it has not been as effective with clean cutting metals. For example, in the laboratory the tapping of SAE 3140 (280 Bhn), SAE 1045 (180 Bhn), and SAE 1112 (120 Bhn) failed to indicate significant differences be-

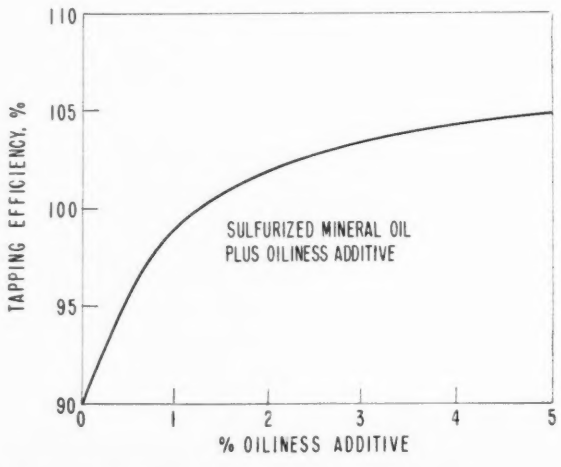


Fig. 5. Tapping Efficiency vs Oiliness Additive.

tween products.

The type of operation also has to be considered when projecting the significance of tapping test results. There has been little correlation with drilling, forming, cutoff, milling, turning, and other operations involving high speeds and low cutting pressures.

Summarizing, the best oil for tapping a soft, draggy steel will probably not be the most satisfactory one for the less severe operations mentioned above. Conversely, an oil which is good for these operations will likely be inferior for tapping and threading.

CONCLUSIONS. Many years of experience have shown that the tapping test is a good tool for evaluating cutting fluids because it is simple, economical, and gives good precision. It can be used on both non-soluble and soluble types for studying the effect of additive material.

The correlation with field performance has been good, especially where severe operations such as threading and broaching are performed on soft, draggy metals.

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(1) H. L. Daasch & J. Hug: "A Study of Torque and Its Influencing Factors as Related to Commercial Tapping of Metals." Bulletin 123, Iowa Engineering Experiment Station, November 1936.

(2) A. J. Carruthers: "Measuring & Interpreting the Factors in Tapping Torques." Paper presented at ASTE Annual Meeting, March 15-17, 1951.

Personals

IN MEMORIUM. L. N. Hodson (ASLE Chicago Section; and son of Walter D. Hodson, one of the founders of the American Society of Lubrication Engineers), President of The Hodson Corporation, Chicago, Ill., died March 22 following a brief illness.

Joseph Dixon Crucible Co., Jersey City, N. J., has announced the following executive appointments: **R. C. Brock**, as General Sales Manager; **D. C. McMillin**, as Ass't General Sales Manager; **A. G. Fletcher**, as Western District Manager; **H. I. Goecker**, as Director of Purchases; and **E. M. Strom**, as Ass't Product Manager of the Graphite & Lubricants Div.

The **Harry Miller Corporation** is the new name of the twenty-year-old chemical manufacturing firm formerly known as the Haas Miller Corp. Located at 4th & Bristol Sts., Philadelphia 40, Pa., the firm has developed and is currently manufacturing and marketing numerous chemical products, oils, and greases used by the metalworking, textile, leather, paper, and plastic industries.

M. B. Peterson, formerly with NACA in Cleveland, has joined General Electric's Bearing & Lubricant Center located in the General Engineering Laboratory in Schenectady, N. Y.

E. F. Houghton & Co., Philadelphia, Pa., has announced three new managerial appointments: **C. A. Biller,** as Manager of the Foreign Sales Dept.; **A. J. Andre,** as Ass't Sales Manager of the Southern Div. (with headquarters in Charlotte, N. C.); and **W. Eismann,** as Acting Research Manager. **F. Ross,** Ass't to the Vice-President in Charge of Sales, has been elected to the company's Board of Directors.

Commercial Filters Corporation of Melrose, Mass., a wholly-owned subsidiary of the Ogden Corp. of New York, has purchased the filter divisions of two Indiana companies: Houdaille-Hershey of Indiana, Inc., and Michiana Products Corp.

S. R. Calish, Jr. (Calif. Research Corp.), Chrmn. of the ASLE Technical Advisory Board, has announced the appointment and acceptance of **R. W. Blair** (Chicago Rawhide Manufacturing Co.) as Chairman of the newly-formed ASLE Technical Committee on Seals & Packings. Members interested in participating in the work of this committee are requested to communicate with Mr. Blair at the Chicago Rawhide Mfg. Co., 1131 Elston Ave., Chicago 22, Ill.

K. Schwartzwalder, Director of Research for the AC Spark Plug Division of General Motors, has been installed as President of The American Ceramic Society.

Obituaries: **W. C. Gardner** (ASLE Louisville Section), Gulf Refining Co., Louisville, Ky., November 29, 1955; **B. P. Brown** (ASLE Chicago Section), Apex Motor Fuel Co., Chicago, Ill., February 17.

Coming Events

JUNE, 17-21, American Society of Mechanical Engineers (Semi-Annual Meeting), Hotel Statler, Cleveland, Ohio.

17-22, American Society for Testing Materials (59th Annual Meeting), Chalfonte-Haddon Hall, Atlantic City, N. J.

17-22, Creative Engineering Seminar, Pennsylvania State University, University Park, Pa.

20-21, APS Division of High Polymer Physics (Joint Symposium with Div. of Colloid Chemistry & American Chemical Society), University of Wisconsin, Madison, Wisc.

21-23, The 1956 Heat Transfer & Fluid Mechanics Institute, Stanford University, Stanford, Calif.

25-29, American Institute of Electrical Engineers (Pacific Summer & General Meeting), San Francisco, Calif.

A. S. L. E. Officers & Directors

ASLE Officers & Directors for 1956-57. The following Officers & Directors were elected at the ASLE 11th Annual Meeting & Exhibit held at the William Penn Hotel, Pittsburgh, Pa., on April 4-5-6, 1956, to serve the American Society of Lubrication Engineers during the 1956-57 term of office. Newly-elected Directors include: D. M. Cleaveland, C. T. Lewis, and D. W. Sawyer; newly-elected Regional Vice-Presidents include: R. F. McKibben (Central), B. H. Miller (Canadian), L. M. Tichvinsky (Western), and A. B. Wilder (Midwestern). E. R. Booser, originally elected Vice-President at Large, assumed the office of President upon the sudden death of Wilbur Deutsch.

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Kansas City ..... E. R. Allgeyer, The Marley Co., 222 W. Gregory, Kansas City, Mo.
Kingsport ..... H. E. Goddard, 407 Cutler St., Greeneville, Tenn.
Los Angeles ..... G. Jepson, Bowser, Inc., 2843 W. 7th St., Los Angeles, Calif.
Louisville ..... J. K. Wyatt, Standard Oil Co. (Ky.), 430 W. Bloom, Louisville 8, Ky.
Milwaukee ..... J. H. Berg, 2537 N. 41 St., Milwaukee 10, Wisc.
Montreal ..... J. H. Whyte, British American Oil Co., 606 Cathcart St., Montreal, P. Q., Canada
New York ..... H. Cunha, National Biscuit Co., 449 W. 14th St., N. Y. 14, N. Y.
N. California ..... A. C. West, California Research Corp., 576 Standard Ave., Richmond 1, Calif.
Ontario ..... K. J. Dean, Shell Oil Co. of Canada, 1120 Main St., E., Hamilton, Ont., Canada
Philadelphia ..... W. P. Finlay, Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.
Pittsburgh ..... J. L. Duchene, Baldwin-Lima-Hamilton Corp., 567 Union Trust Bldg., Pitts., Pa.
Saginaw Valley ..... J. A. Norton, P. O. Box 6-104, Flint 6, Mich.
St. Louis ..... L. F. Hartmann, Olin-Mathieson Chemical Corp., East Alton, Ill.
Syracuse ..... E. J. Naughton, 182 Clyde Ave., Syracuse, N. Y.
Twin Cities ..... C. D. Johnson, Twin Cities Test. & Engrg. Lab., 2440 Franklin Ave., St. Paul 4, Minn.
Wheeling ..... S. J. Litten, Sun Oil Co., 910 Pearl, Martins Ferry, Ohio
Youngstown ..... J. A. Weber, 166 N. Middle St., Columbiana, Ohio

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By-Laws ..... W. H. Millett, Carbide & Carbon Chemicals Co.
Editorial ..... R. K. Gould, The Texas Co.
Education ..... B. G. Rightmire, Massachusetts Institute of Technology
Exhibit Arrangements ..... J. D. Lykins, Wheeling Steel Corp.
Finance ..... C. C. Blaisdell, Penola Oil Co.
Handbook Advisory ..... C. R. Schmitt, E. F. Houghton & Co.
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Industry Relations ..... J. P. Critchlow, Gulf Oil Corp.
Membership & Admission ..... B. T. Harding, Midwest Oil Co.
National Meeting (Annual—Detroit)
National Meeting Manual ..... A. S. McNeilly, Esso Standard Oil Co.
New Sections ..... W. P. Youngclaus, Jr., ASLE National Office
Nominations ..... J. W. Hopkinson, Penn-Petroleum Corp.
Program (Annual Meeting—Detroit) ..... C. R. Lewis, Standard Oil Co. (Ind.)
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Reorganization of ASLE Committee Structure

(Adopted by the Board of Directors • January 19, 1956)

I. General Committee Structure of the Society

A. Technical Committee Organization

1. Technical Advisory Board—(TAB)

General responsibility for the operations, policies and finances of the individual Technical Committees of the society shall be vested in a Technical Advisory Board. (This supplants the General Technical Committee and until such time as the By-Laws can be amended will technically be the General Technical Committee required by those By-Laws.) This Board will consist of a 6-member Executive Committee, together with the Chairmen of the individual Technical Committees. The Executive Committee members shall be elected to that committee: two to be elected each year by the Board of Directors to serve for a three-year term. This election shall take place at the Annual Meeting of the Board of Directors and nominees for election to this Executive Committee shall be secured by the Committee on Nominations following the same procedure as that used for presenting nominees to serve as Officers of the Society. Retiring members of the Executive Committee of the Technical Advisory Board shall not be eligible for renomination to that same office for a period of one year following expiration of their term. (In the case of the election of the first Executive Committee, this shall take place at whatever regular or special meeting of the Board of Directors they shall prescribe, and two members shall be elected to serve a one-year term; two to serve a two-year term and two to serve a three-year term.) The Executive Committee of the Technical Advisory Board shall have the prime responsibility for the actions of that Board, with the Chairmen of the individual Technical Committees serving in an advisory capacity. Vacancies occurring in the Executive Committee of the Technical Advisory Board shall be filled by action of the Board of Directors for the unexpired term.

The Technical Advisory Board shall have liaison with the Board of Directors and its Executive Committee through the Vice-President at Large, who shall serve as its Board Sponsor. The Vice President at Large shall, each year, at the time he takes office, select from the membership of the Executive Committee of the Board a vice chairman for that Board, who shall automatically succeed to the chairmanship at the close of the Annual Meeting the following year. (In the case of the first Board, its chairman shall be appointed by the President.) The Chairman of the Technical Advisory Board shall be without vote in the proceedings of that Board, except in the case of a tie vote. The duties of the Technical Advisory Board shall be prescribed in whatever detail is needed by acts or resolutions of the Board of Directors in keeping with the broad purpose outlined above. Among these responsibilities shall be that of liaison with other technical societies. Such subcommittees as are necessary to the proper carrying out of its duties and responsibilities may be established by the Technical Advisory Board from time to time as the need arises. The Technical Advisory Board shall meet at least once annually, at the time of the Annual Meeting, and at such other times as it deems necessary.

2. Technical Committees

The Technical Committees shall be the agents of the Society in technical matters, under the general supervision of the Technical Advisory Board as outlined above. It shall be the responsibility of the Chairman of the Technical Advisory Board, at the time he takes office, to secure suitable chairmen for the individual Technical Committees (subject to final approval and appointment by the President of the Society as required by the By-Laws) and to report the names of these committee chairmen to the Vice-President at Large no later than the regular May-June meeting of the Board of Directors. Chairmanship of a Technical Committee shall be limited to a maximum term of three years, with a two-year lapse necessary before reappointment of the same person to the chairmanship of the same committee. However, this should not be construed as preventing the retiring chairman of a given committee from serving as chairman of some other committee the following year. Each Technical Committee shall establish such subcommittees as it finds necessary, drawing upon membership of the committee and the Society at large. The subcommittees and functions of the Technical Committees shall include the following:

a) Research Subcommittee, the function of which shall be the development and execution of projects in the given field of the Technical Committee, of direct benefit to the Society membership or to industry.

b) Papers and Publications Subcommittee, the functions of which shall be the sponsorship of tech-

nical sessions on subjects in the Committee's field, at national meetings of the Society, based on papers solicited and reviewed by the Subcommittee, (according to procedures established by the Program Committee and in cooperation with the Program Committee) and solicitation and sponsorship of other papers or manuscripts, including those presented at local Section meetings, on subjects in the Committee's field, for publication by the Society in its Journal or in some other form (in cooperation with the Editorial Committee).

c) Information Subcommittee, the functions of which shall be the development, and publication through the Society, of recommended procedures and practices in the Committee's field, and the answering of requests for technical information, received by the Society.

3. Finances

Where a Technical Committee finds the need for financing certain of its projects and activities with Society funds, the following procedure shall be followed:

The Technical Committee shall submit a detailed statement of its need for such funds to the Technical Advisory Board at the time of the Annual Meeting. From these statements received from the Technical Committees, the Technical Advisory Board shall prepare a proposed annual budget for the coming year and submit it to the Vice-President at Large and the Finance Committee no later than September 1 of each year, in time to be incorporated by the Finance Committee into the proposed annual budget for the Society. Money for meeting this Technical Budget shall come from dues paid by Industrial Members of the Society, and the budget shall not exceed 50% of the total gross income from these dues. (It is further recommended that much of the remainder of these dues be used to sponsor other research and professional development projects of the Society, such as scholarships and fellowships.)

B. Other Committees of the Society

1. Director-Sponsorship of Committees

a) The Society committees shall be organized under eight main classifications as outlined below, with each Director of the Society being responsible, as Director-Sponsor, for one of these classes. Assignment of each Director's class of committee responsibility, shall be made by the President at the first meeting of each new Board of Directors. A Director-Sponsor shall be a member ex-officio of each of the committees in the class assigned to him as in the past, but shall have prime responsibility for seeing that each such committee functions and carries out its prescribed duties during his term of office. He shall be responsible for passing on to his successor Director-Sponsor on the Board his complete files covering these Committee responsibilities. The classes of committees, with present committees indicated under them, are set forth below:

Industry Committees
Industry Relations
Industry Advisory
Professional Development Committees
Awards
Education
Publications Committees
Editorial
Abstracts
Handbook Advisory
Meetings Committees
Program
Annual Meetings
Exhibit Arrangements
Lubrication Conference
Membership Committees
Membership and Admissions
New Sections
Industrial Membership
Projects Committees
Projects
Journal Bearing Research Project
Rules Committees
By-Laws
Operations Committees
Nominations
Finance

b) It shall be the responsibility of each Director-Sponsor and the president to secure suitable chairmen (or vice chairmen in the case of committees for which automatic succession of the vice chairman to chairmanship is prescribed) for each of the committees for which he is responsible (subject to final approval and appointment by the President of the Society as required by the By-Laws and with the exception of the Nominations, Finance, and Editorial Committees as provided for in the By-Laws) and to report the names of these committee chairmen to the President no later than the regular May-June Meeting of the Board of Directors. It shall be the duty of the Director-Sponsor to instruct his new committee chairmen in the mechanism of liaison with the Board of Directors, including the fact that he shall supply the sponsor with copies of all pertinent committee correspondence through his term of office and shall bear in mind that the Director-Sponsor is a member ex-officio of the Committee and is expected to attend meetings of the committee unless prevented by circumstances beyond his control.

2. Chairmanship of Committees

Chairmanship of a Society committee (with the exception of the Finance and Editorial Committees) shall be limited to a maximum term of three years, with a one-year lapse necessary before reappointment of the same person to the chairmanship of the same committee. However, this should not be construed as preventing the retiring chairman of a given committee from serving as chairman of some other committee the following year.

(Continued on next page)

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(Continued from p. 207)

3. Finances

Where a committee finds the need for financing a project or activity with Society funds, the following procedure shall be followed:

The committee shall submit a detailed statement of its need for such funds to its Director-Sponsor at the time of the Annual Meeting. From these statements, received from his committees, the Director-Sponsor shall prepare a proposed annual budget for his class of committees and submit it to the Finance Committee no later than September 1 of each year, in time to be incorporated by the Finance Committee into the proposed annual budget for the Society.

II. Promotion of Committee Service by Society Members

It shall be the responsibility of the President-Elect, with the assistance of the Administrative Secretary, the Officers and Directors of the Society, and the individual committee chairmen, to promote membership on Society committees. The following procedure is recommended:

Annually, not less than 30 days before the Annual Meeting, the Secretary shall transmit to all voting members of the Society a letter inviting their participation in Society committees, including a numbered list of all committees, technical and general, of the Society.

A stamped return postal card, addressed to the National Office, would be enclosed, bearing all committee numbers and a place for the member's signature and preferred address for committee correspondence. From the returned postcards, the National Office staff would compile lists of names and addresses for each committee. These would be submitted to the corresponding Director-Sponsors by the incoming President at the time of the Annual Meeting, for use by their committee chairmen. Sponsors should instruct their committee chairmen to use all possible volunteers and to write the remainder a letter of thanks and regret that their services could not be used in the current year on the particular committee. Chairmen should urge these to volunteer again in the future and meanwhile to promote the committee's aims and activities in their local Sections.

TAB ELECTIONS

Under the reorganized structure the following candidates names were supplied to the Board of Directors by the Committee on Nominations: One Year Term: R. G. Larson, T. A. Marshall, and D. F. Wilcock. Two Year Term: D. D. Fuller, R. H. Josephson, and E. M. Kipp. Three Year Term: S. R. Calish, W. E. Campbell, and A. A. Raimondi. Balloting by the Board of Directors elected Messrs. Larson and Marshall for the one year term, Josephson and Kipp for two years, and Calish and Raimondi for three years. S. R. Calish was appointed chairman for TAB and A. A. Raimondi was appointed vice chairman.

(Experiment, from p. 170)

boss of the slippers. The slippers, being grooved to the center of this position and then drilled, will allow the lubricant to move in all directions and give plenty of lubricant to cover both front and back of slipper movement. With this method of lubrication we have been able to increase the life of slippers by 200 to 300%. The application is made only once every 24 hours. We attribute the type of grease, as well as the method of application, to the increased life of the slippers.

(Section News, from p. 192)

the various functions of the gear lubricant.

April. G. T. Coker, Jr., Petroleum Research Technologist for Shell Oil Co., presented a paper entitled "Use of Emulsions as Fire-Resistant Power Transmission Fluids," discussing a water-in-oil emulsion which has been developed to fulfill the need for a low-cost, fire-resistant industrial hydraulic fluid. (Submitted by A. C. West, Sec'y.)

(Continued on p. 211)

STAYS

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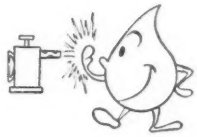
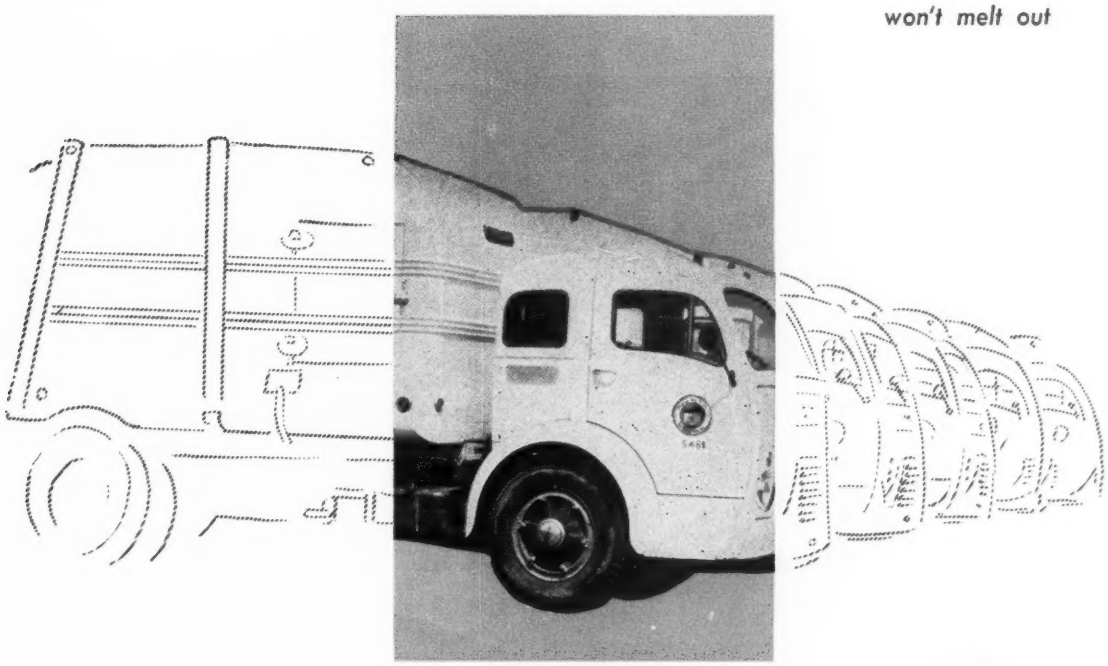


won't melt out



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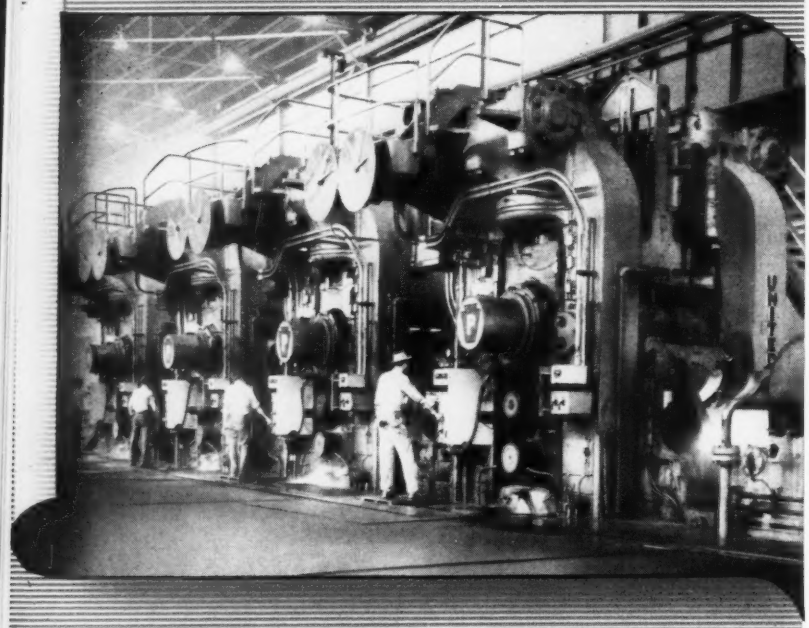

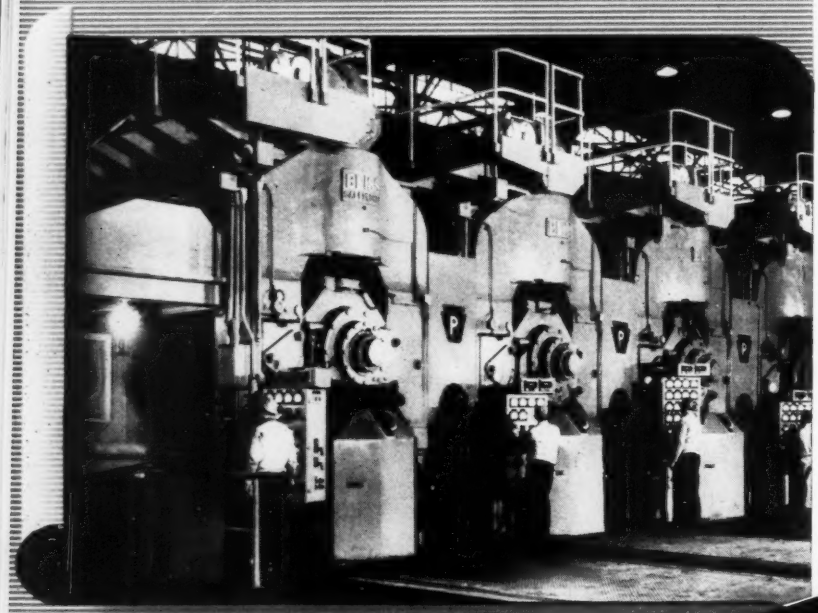

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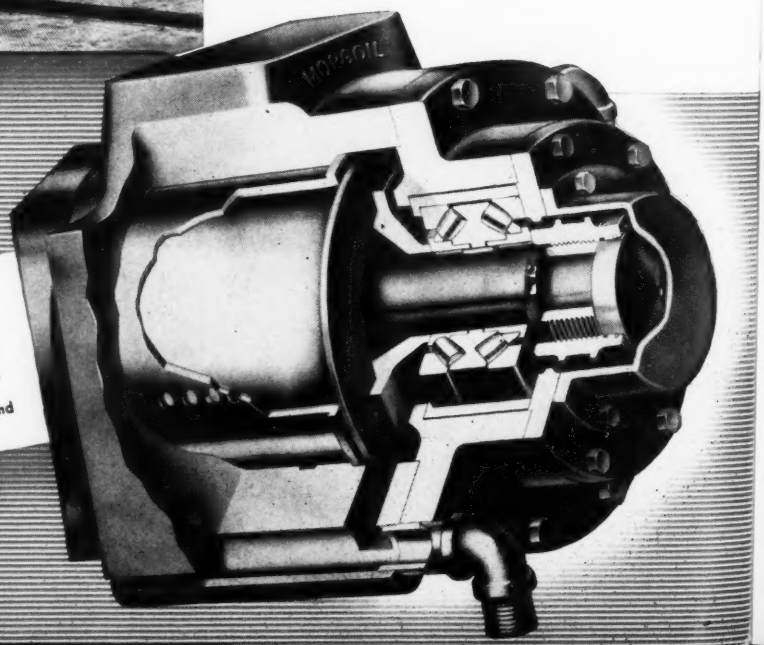

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(Section News, from p. 208)

ONTARIO, September '55 meeting. R. C. Stewart, Chief Metallurgist for Vanadium-Alloys Steel Company of Canada, Ltd., presented a paper entitled "The Evolution of Cutting Fluids."

October '55. "Fitting Xylons in Industry," by P. Kingsmill, Sales Manager for Peckovers' Ltd.

November '55. "Water Separation and the Dehydration of Lubricating Oils," by R. L. Leslie, Research Engineer for Houdaille-Hershey Corp.

December '55. "The Science of Ball Bearing Lubrication," by D. F. Wilcock, Manager of the Chemical Process Dept., General Electric Co.

January. "Evolution of Petroleum Lubrication," by G. McIntyre, Imperial Oil Co., Ltd. (Submitted by M. J. O'Reilly, Section Director.)

PITTSBURGH, February meeting. E. M. Arentzen (Lee-Norse Co.), A. E. Molinski (Bethlehem Mines Corp.), and F. C. Roberts (Gulf Oil Corp.) spoke on the subject "Lubrication in the Coal Industry." (Submitted by S. W. Settle, Publicity Chrmn.)

SAGINAW VALLEY, February meeting. Joint meeting with Professional Engineers, featuring E. N. Cole, Chief Engineer for Chevrolet Motor Div., GMC, as guest speaker.

March. "Principles of Refinery Operation," by C. Fiske, Refinery Engineer for Leonard Refineries.

April. Tour of Bay Refining Corporation, with F. J. Tiernan, Plant Superintendent, as Host.

May. "Petroleum, Synthetic & Water-Base Hydraulic Oil Maintenance & Reclamation," by F. M. Steele, Hilliard Corp.

September 27. "The Engineer's Part in Local & National Civil Defense," by T. Kay, Administrative Aid to Flint City Manager.

October 25. Tour of Dow Corning Corporation.

December 6. "What Do Additives Accomplish?" by A. O. Willey, Lubrizol Corp. (Submitted by J. A. Norton, Sec'y.)

TWIN CITIES, February meeting. C. R. Schablitzke, The Texas Co., presented a paper entitled "Industrial Lubrication."

March. Section - sponsored 'Fundamentals of Lubrication' Course (6 weeks), held at the Dunwoody Industrial Institute. (Submitted by C. D. Johnson, Sec'y.)

YOUNGSTOWN, March. Informal dinner-dance as third annual "Ladies' Night." (Submitted by J. A. Weber, Sec'y.)

Lubrication Abstracts

(This is the fifth in a series of abstracts of translations of Foreign articles on lubrication, by Henry Brutcher. Copies of the full translations are available, at the indicated prices, by writing Mr. Brutcher at P. O. Box 157, Altadena, Calif.)

Drawing Experiments with Alloy Steel Wire Under Different Conditions, by W. Lueg & A. Pomp; "Stahl und Eisen," Vol. 70, No. 22, 1950, pp. 977-984; 7 figs., 3 tables, 5,900 words. Importance of good adhesion of lubricant to steel surface in cold drawing. Value of suitable lubricant carrier. Experimental arrangement. Steels drawn: low Cr cold-drawn steel with spheroiditic structure; high speed steel (8½% W, 4 Cr, 1.8 V); and 18-8 steel with 0.5% Co + 0.5% Ti. Lubricants used: dry soap and commercial drawing grease with addition of oil. Experimental program and procedure. Conditions of drawing selected for the different series. Evaluation of experimental data. Single-draft experiments with increasing percent reductions. Experiments involving sequences of 3-4 drafts and conducted under varied conditions of drawing. Experiments on the drawing of 18-8 Ti + Co steel involving an eight-draft sequence without process anneal. Advantage of an additional lubricant carrier to insure better adhesion of lubricant. (Order No. 2623, Price $11.40)

Measurement of Temperature in the Drawing of Bar & Wire Stock and the Problem of Supercritical Drawing Speeds, by W. Reichel; "Stahl und Eisen," Vol. 70, No. 25, 1950, pp. 1141-1146; 11 figs., 4,700 words. Cold draw-

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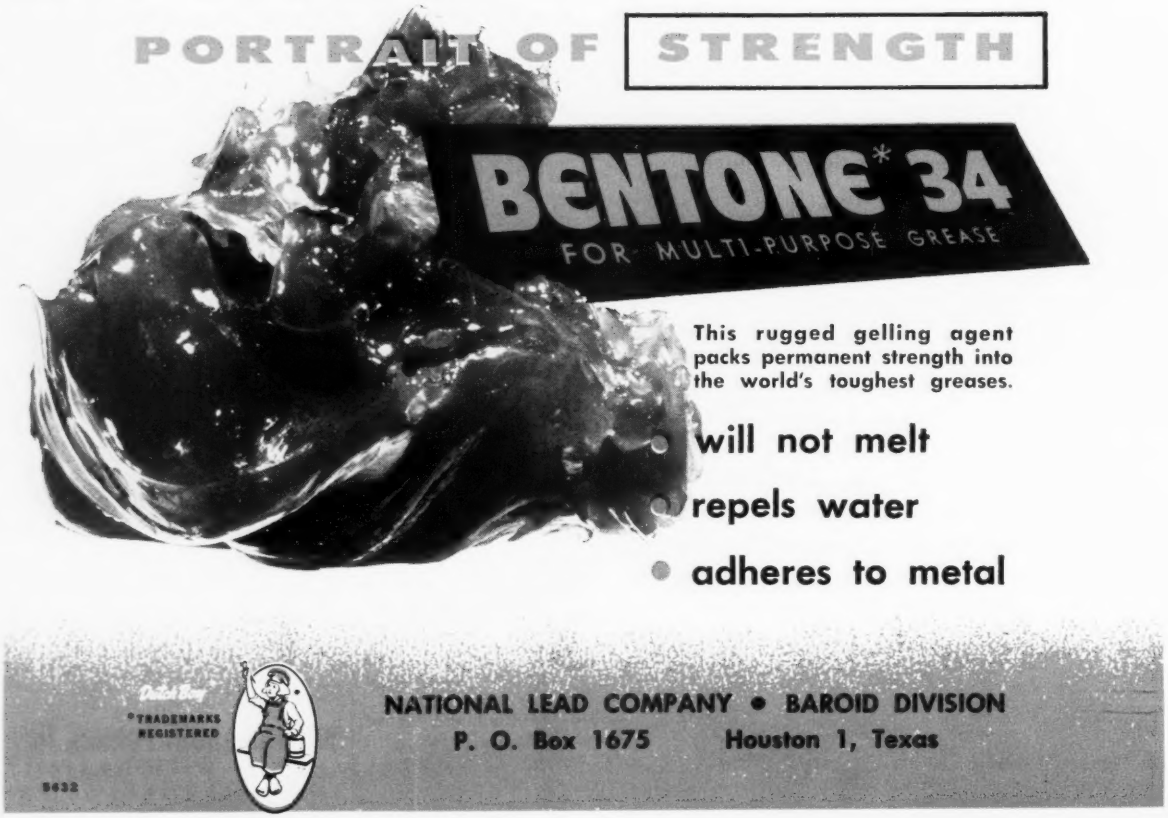
ing temperature, measured where drawing die and stock make contact, as a criterion of the drawing process. Temperature measurement by use of "thermopairs;" calibration of the latter. Examples illustrating a proposed method of determining the most favorable die designs and drawing speeds. Testing the performance of drawing lubricants. Temperature measurements by the "two-steel method" in single and multiple drawing. Temperature conditions in the drawing of bar and wire at supercritical speeds, where the temperature in the drawing tool falls off. Conclusions drawn from machining operations. Application of lessons learned to the design of better cold drawing equipment. General discussion. (Order No. 2670, Price $9.40)

Metal Soaps (Stearates) for the Drawing of Steel Wire, by K. Schimz; "Draht," Vol. 4, No. 8, 1953, p. 297; 600 words. Summary of results of unpublished experimental work of Max-Planck Institute for Iron Research on the performance of metal soaps in wire drawing. Nature of metal soaps studied (aluminum, calcium, and lead stearates); data on their melting point, bulk density, and ignition residue. Best soaps for ordinary low-carbon steels and for high-grade or alloy steels, resp. Advantages of stearates studied over lime soaps and greases. Possibility of mixing them with lime or dry drawing soaps. Soaps suitable for the drawing of mechanically descaled wire. (Order No. 3165, Price $1.60)

Investigation of Lubricating Action in Deep Drawing Using a Model, by S. Ya Veiler, L. A. Shreiner & P. A. Rebinder; "Doklady Akademii Nauk SSSR," Vol. 73, No. 3, 1950, pp. 511-513; 1 fig., 2 tables, 1,200 words. Development of a new method for testing the efficacy of lubricants in deep drawing as well as the deep drawing properties of metals. Particulars on testing setup (Fig. 1). Simultaneous determination of tangential tensile and radial (normal) compressive forces, with various amounts of deformation. Computation of nominal friction coefficient and effective deep drawing stress as the principal characteristics of lubricating action from these data. Metals used in tests: low-carbon steel and brass. Constancy of effective drawing stress in relation to amount of deformation, under the most varied conditions. Possibility of using the proposed method for testing lubricants differing widely in consistency, as well as metallic coatings for their lubricating power at various temperatures. Usefulness of method as a control test at works laboratories and for developing formulas for lubricants and coolants. (Order No. 3195, Price $2.40)

Lubricant Carriers Used in the Drawing of High & Low Carbon Steel Wires, by W. Lueg & K. H. Treptow; "Stahl und Eisen," Vol. 72, No. 20, 1942, pp. 1207-1212; 3,900 words. Critical review of literature on the principal groups of lubricant carriers currently used in the drawing of steel wire having low and high carbon contents and on the requirements to be met by these carry-agents. Lime: preparation, compositions, properties, and applications; Borax: properties and uses, its advantages over lime. Development of additional alkalies as carry-agents. Use of graphite in special cases at wire mills and results obtained. (Order No. 3244, Price $7.80)

Negative Lubricating Action of Some Liquid Media in the Deep Drawing of Metals, by S. Ya Vieler; "Doklady Akademii Nauk SSSR," Vol. 83, No. 5, 1952, pp. 709-712; 1 fig., 1 table, 1,550 words. Criterion used for judging the effectiveness of lubricants in the deep drawing of metals. Liquid lubricants exerting a negative effect (compared with dry drawing). Experimental procedure. Material deep drawn: 0.09-0.15% carbon steel. Tangential drawing forces as function of length of carbon chain of lubricants (Fig. 1, alcohols, acids, and hydrocarbons) tested. Effect of negative and positive lubricants on amount of reduction and surface hardness of steel specimens (Table I). Explanation of results obtained with solid lubricants; activated aqueous liquids (aq. soap soln.); and organic negative lubricants. (Order No. 3251, Price $3.35)



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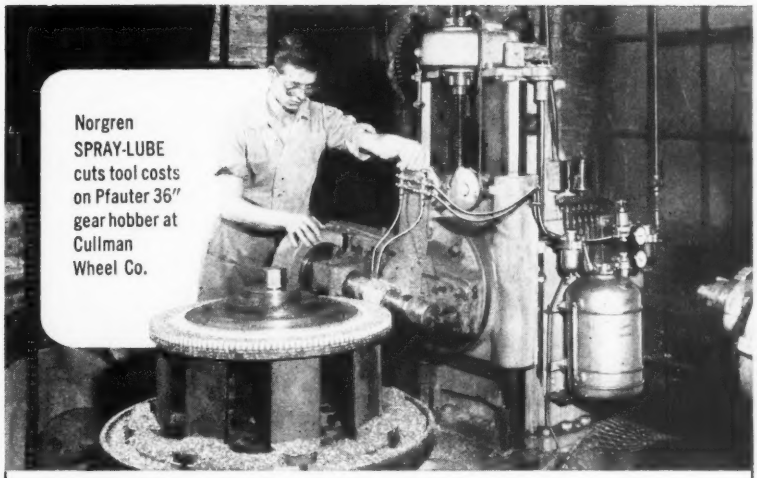
1000 Bearing-Inch Lubricator. Pictured above is the new Micro-Fog Lubro-Control Unit that automatically creates a finely-divided, air-borne oil fog which can be uniformly distributed through complex piping systems to multiple lubrication points. A single unit can completely lubricate even the largest machines — up to 1000 bearing inches. Two pressure switches and a float-controlled switch are provided for connection to a control panel, if desired, to actuate an automatic alarm system or controls when air pressure fails, when excessive pressure develops in the oil reservoir, or when the oil supply needs replenishing. The unit is small, compact, and complete, measuring only 12" x 11" x 9"; it contains all necessary controls plus a 2-gallon oil reservoir. An automatic drain filter protects the unit, the lubricant, and the bearings by removing abrasive and corrosive air line contaminants; and drains the collected liquids automatically. (C. A. Norgren Co., LE-12/3, 3400 S. Elati St., Englewood, Colo.)

Tube Fittings. Zytel Miracle Fittings, a simplified line of tube fittings made from duPont's Zytel nylon resin and consisting of two parts instead of the conventional three, require no flaring of the tube and permit re-use of tubing. This simplification is made possible by incorporating the com-



$250 Saved Yearly in Lubricant Alone on Each Gear Hobber with SPRAY-LUBE*

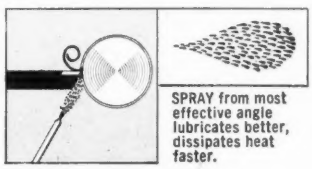
...Cullman Wheel Co. also reports substantially increased tool life, safer, cleaner working conditions, less machine cleanup time.

Cullman Wheel Company in Chicago is a leading manufacturer of chain drives and other power transmission equipment. Dissatisfied with the performance of flood systems of tool lubrication, they tried Norgren SPRAY-LUBE on one of their gear hobbers.

Results of the trial were so favorable that they at once began converting the coolant systems on other gear hobbers and shapers to Norgren SPRAY-LUBE.

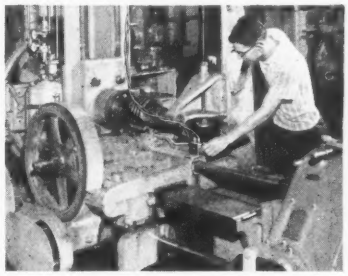
Today, from the many SPRAY-LUBE applications in their plant, they have reported the following facts:

Norgren SPRAY-LUBE applies a spray of cutting oil upon the close interfaces at the cutting area, providing a more thorough lubrication at the cutting point between the tool and work piece. As a result, tool life has substantially increased.



SPRAY-LUBE sprays lubricant exactly where it is needed with no waste. It does a much more thorough lubricating job, using considerably less lubricant. In fact, savings in lubricant cost alone are averaging $250 a year per machine —enough to pay for the Norgren SPRAY-LUBE System in about 6 months.

In addition, SPRAY-LUBE has provided other valuable advantages —improving product finish . . . simplifying chip removal . . . reducing machine cleaning time . . . and providing safer, cleaner floor conditions around the machines.



Norgren SPRAY-LUBE saves nearly $250 a year in coolant cost on Gould & Eberhardt gear shaper.

Without obligation, learn how Norgren SPRAY-LUBE can reduce costs in your plant. Call your nearby Norgren Representative listed in your telephone directory — or **WRITE THE FACTORY FOR BULLETIN 537.**

C. A. Norgren Co.

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**For complete information about this application, write for Norgren Blueprint SL-7.*

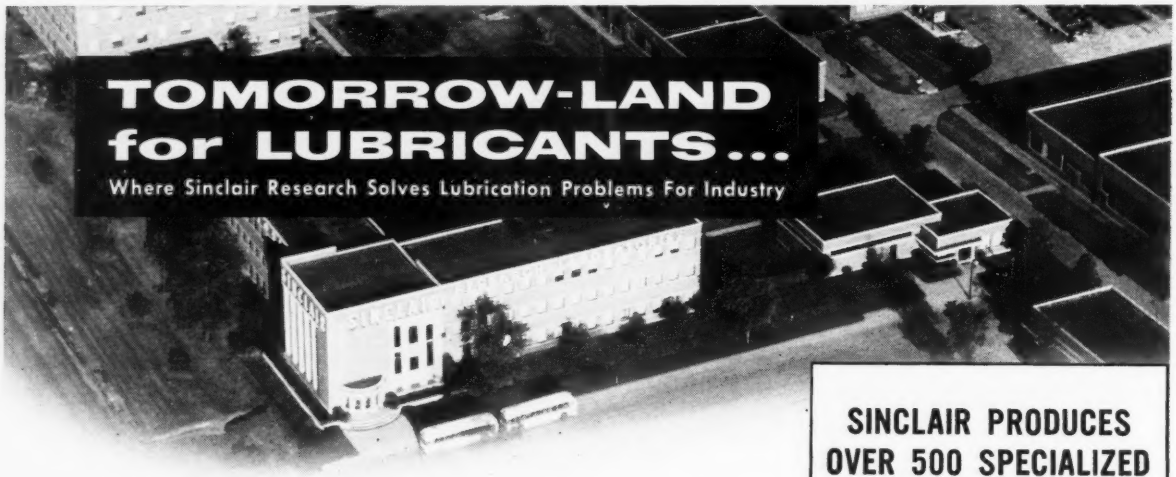
pression section as an integral part of the nut. The fittings, which can be used with any type of tubing — metal or plastic, are available for tubing with outside diameters ranging from ¼ through ½ inch; pipe sizes run from ⅛ to ½ inch. The design of these fittings does not require tubes cut to exact lengths. Leakproof connections can be made without indenting or "necking" the tubing; thus, both fitting and tubes can be re-used. (Jaco Manufacturing Co., LE-12/3, P. O. Box 2659, Cleveland 7, Ohio.)

Rust Check Spray. "Rust Chek," a new, rust preventive spray for use on tools, molds, dies, instruments, nested metal parts, and machinery, comes packaged in a 12-ounce aerosol spray container providing approximately 80 square feet of coverage in the form of a clear, dry, waxy film to a thickness of .0005. Except in the case of use on precision instruments where critical tolerances are to be held, the film need not be removed when the protected tool, mold, machinery, etc., is removed from storage or tool crib and readied for use; the film is worked off in the using, and in some applications such as on power saws, it serves as a lubricant. Submersion tests in salt water and in other liquids simulating various industrial atmospheric conditions indicate that the new product will provide complete and permanent protection for tools, dies, molds, machinery, and metal surfaces during storage periods or in transit. (Eastern Aerosol Products, LE-12/3, Newfoundland, N. J.)

Chlorofluorocarbons. Technologists at Battelle Institute have found that chlorofluorocarbons, used as lubricants, exhibit great thermal stability, good load-carrying capacity, and stability in oxygen. The extreme high-temperature stability of these materials is apparently related to the very strong intramolecular bonds resulting from the presence of the fluorine atoms, while the complete absence of hydrogen in the chlorofluorocarbon molecule contributes to its stability in the presence of oxygen. The chlorine atoms are thought to be responsible for the high load-carrying capacity exhibited by these compounds. Reasonable compatibility of these chlorine- and fluorine-saturated carbon-chain compounds with other lubricants makes the following uses technically feasible: as lubricants for bearings operating under high loads, as lubricants and sealants for bearings and pistons operating under severe oxidizing conditions (such as in oxygen compressors and pumps), and as additives to increase the load-carrying capacity and lubricity of natural and synthetic lubricants without diminishing the stability of the latter. (Battelle Memorial Institute, LE-12/3, 505 King Ave., Columbus 1, Ohio.)

Safety-Type Fluid. "Cellulube 220," a new, straight chemical synthetic (non-petroleum) oil, is now being used in the hydraulic systems of deck-edge elevators on U. S. Navy aircraft to minimize fire and explosion hazards. (Celanese Corp. of America, LE-12/3, 180 Madison Ave., New York 16, N. Y.)

Surface-Active Agent. "Isomal 265," a new anionic surface-active agent, has been developed to be



Located at Harvey, Illinois, is one of the most extensive installations of its kind in the world—Sinclair Research Laboratories. These facilities are an important part of Sinclair's investment in the future. Here is where Sinclair engineers and chemists work to develop new products and improve the quality of existing ones. At these famous laboratories were developed the Sinclair lubricants now solving difficult problems in all branches of industry. If you have a special lubrication problem, write today to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y.

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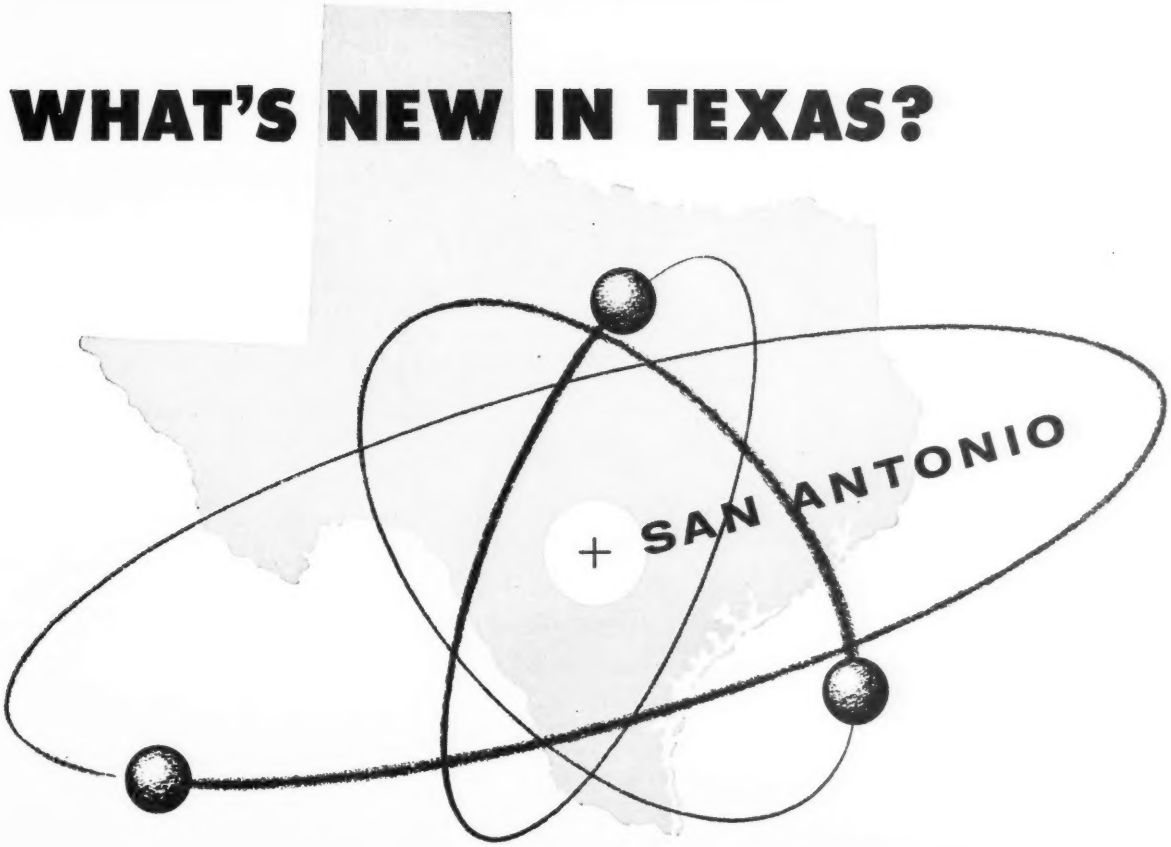

NEW SOURCE OF Lithium Hydroxide

The new $6,600,000 plant of American Lithium Chemicals, Inc. in San Antonio, an affiliate of American Potash & Chemical Corporation, long the leading producer of Lithium Carbonate, makes available to producers of lithium-based greases an abundant new source of supply of LITHIUM HYDROXIDE. The new plant will process high-grade lithium ores from extensive deposits in Southern Rhodesia, assuring you of vast reserves, coupled with the most modern domestic production facilities available anywhere. You can count on the advantages of Trona LITHIUM HYDROXIDE in your all-purpose greases—moisture resistance, chemical and mechanical stability and wide temperature range, just as you can depend on the consistent good quality of Trona's new source of this vital all-purpose, all weather grease additive.

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used in all kinds of industrial processes as a wetting agent, rewetting agent, penetrant, detergent, and emulsifier. Specially formulated to reduce processing time, increase processing efficiency, and improve finished products, the new fluid is a concentrated sulfonated ester-type liquid having a neutral pH factor and a specific gravity of 1.088 at 60 F. High operating efficiency is obtained from a unique balance of lipophilic and hydrophilic elements; the solution is compatible with both non-ionic and other anionic agents. It is stable at elevated temperatures (up to 210 F.), and has no upper or lower cloud point. (The Johnson-March Corp., LE-12/3, 1724 Chestnut St., Philadelphia, Pa.)

Injected-Molded PVC Plug Valve. The first "self-lubricated" plug valve to be injection-molded of polyvinyl chloride is now being marketed to reduce replacement costs and downtime, minimize purging, and eliminate the product contamination problems often experienced when certain fluids encounter metallic components of piping systems. Teflon bearing buttons on the plug provide the self-lubricating characteristic; other features include: a straight-through-port that makes possible unimpeded flow conditions, adjustments to compensate for wear, positive closing, and self-indicating port positions. Furnished with threaded ends, or with socket-type ends for solvent welding, a nub on the bottom can be tapped for insertion of a drain plug if desired. At present the new valve will be furnished in 1", 1½" and 2" sizes to match pipe of corresponding nominal size (these sizes may also be used with ½", ¾" and 1¼" piping by employing bushings); later, the company will go into the production of 3" and 4" valves. (Tube Turns Plastics, Inc., LE-12/3, 2929 Magazine St., Louisville 11, Ky.)

Mist Lubrication Device. A new device for automatically applying a controlled, pre-measured quantity of mist lubrication on open gears, chains, cams, rollers, eccentrics, slides and ways, circular saws, and similar surfaces has recently been announced. The device, called the "MistOmatic Spray Control," was designed for use in conjunction with the company's power-operated, time-clock controlled centralized lubrication systems which, in combination, permits automatic, simultaneous lubrication of both closed bearings and open surfaces at pre-set time intervals. (Lincoln Engineering Co., LE-12/3, 5743 Natural Bridge Ave., St. Louis 20, Mo.)

New Model Cowles Dissolver. New, improved models of Cowles Dissolvers have been announced, together with an expanded plan for demonstration in users' plants without obligation to buy. The new models feature motor placement that substantially reduces head-room requirements on many of the models, stainless steel construction that eliminates risk of contamination, patented impellers for a wide variety of applications in the process industries, and other advancements. Peripheral speeds of impellers range from 3600 to 6000 rpm, producing extreme sheer and impact. Designed

for processors of liquid-liquid, gas-liquid, and solid-liquid products, they are applicable to materials with viscosities up to and in excess of 50,000 centipoises, including paints, inks, chemicals, foods, plastics, and similar materials. Demonstrations will be made in processors' own plants, on their own products, without obligation. Morehouse Mills will be demonstrated on the same basis, separately or in conjunction with Cowles Dissolvers. (Morehouse-Cowles, Inc., LE-12/3, 1150 San Fernando Rd., Los Angeles, Calif.)

Vanlube AZ. Commercial availability of Vanlube AZ has been announced, satisfying the need for a truly oil-soluble metal dithiocarbamate. Chemically, Vanlube AZ is zinc diamyl dithocarbamate, and is supplied as a 50% concentrate in a light mineral oil. It has the following typical properties: Specific Gravity, 0.980; Viscosity SUS @ 100 F., 590 — @ 210 F., 60; ASTM Color, 1½; Ash as Zinc Oxide, 7.6. It is effective at low concentrations, and laboratory tests indicate that it has all the desirable properties of the company's Butyl Zimate (zinc dibutyl dithiocarbamate) when used at equivalent concentrations. (R. T. Vanderbilt Co., Inc., LE-12/3, 230 Park Ave., N.Y., N.Y.)

Silicone Lubricant & Preservative. A new silicone product has been developed to lubricate and preserve rubber shock mountings, and door, hood, and trunk weather strippings. Identified as Dow Corning 4X Compound, the lubricant also prevents weather stripping from freezing in place in cold weather, makes ignition systems sure-starting in damp weather, is an effective "anti-seize" for wheel lug nuts, and reduces the white corrosion that forms on battery terminals and cases. Available from most auto parts distributors in 2-ounce or 8-ounce tubes. (Dow Corning Corp., LE-12/3, Midland, Mich.)

Circulating Oil Systems. A new line of "CS" Circulating Lubrication Systems has been introduced

(Continued on p. 220)

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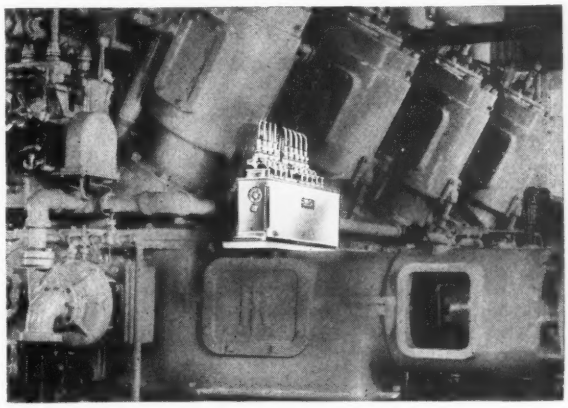

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JOHN BUTLER TYTUS *dreamed that steel could be rolled in a continuous strip. In 1904, fresh from Yale University, he went to work as a laborer in the rolling mill to learn the craft, rose to mill superintendent and worked out the techniques and blueprints of his continuous rolling mill during World War I. It took him until December, 1923, to build the first mill and another six months of trial operation to produce satisfactory sheets. Today, billions of dollars worth of smooth-finished, deep-drawing sheets roll at ever-increasing speeds from the continuous mills of America.*

Great Names in Steel Making #1

To the public, beneficiary of the high quality and lower cost of continuous rolled steel in a thousand products, John Butler Tytus is virtually unknown. But within the steel industry, his is one of the great names.

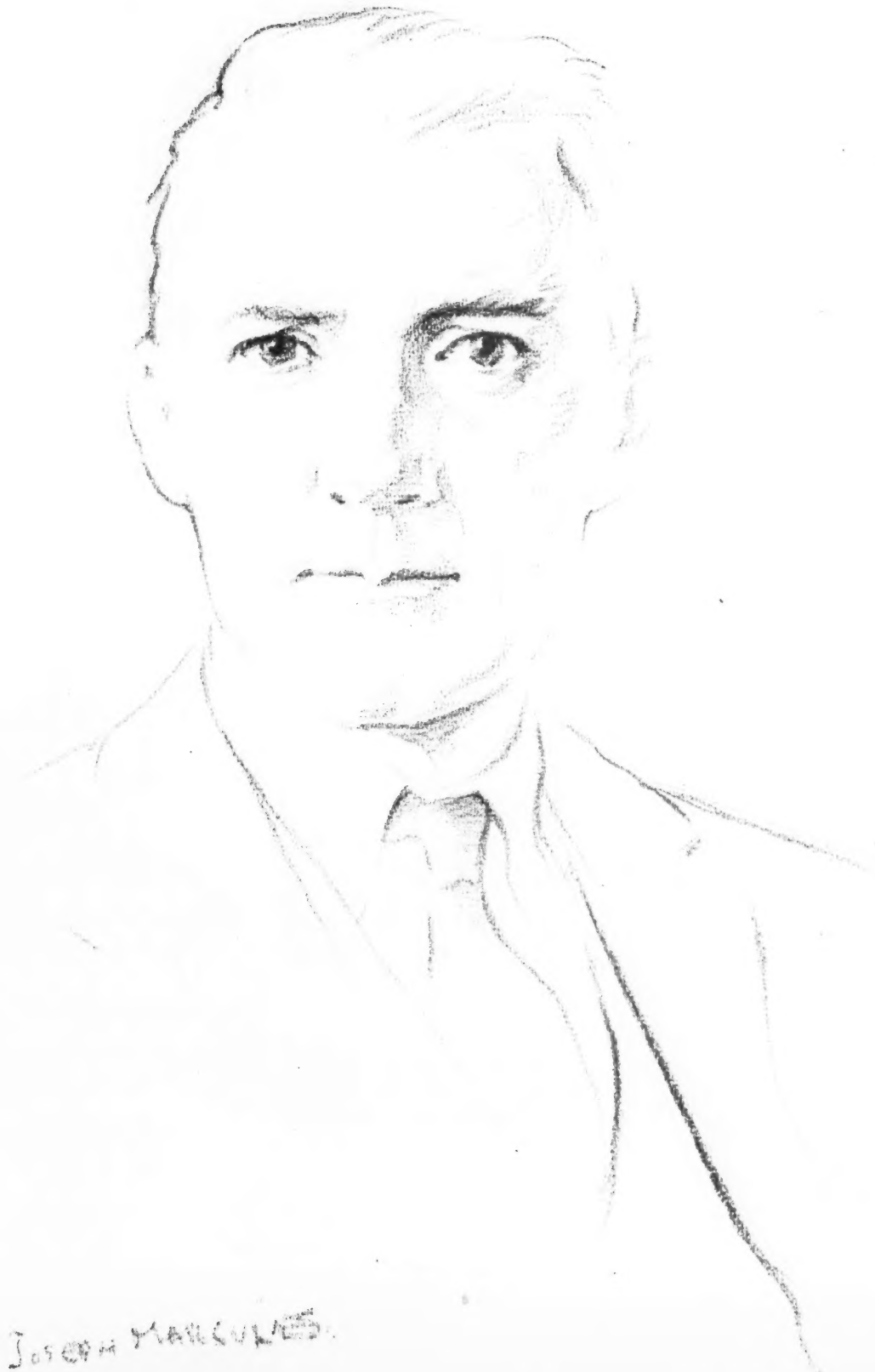
There are other names — names of men and of products — similarly unknown to the public but of important significance to steel men. The name "Palmoshield" is an example.

It is four years since Fortune magazine carried the first report of Palmoshield: "New All-American Lubricant Frees Rolling Mills from Hazards of Foreign Supply." The time was March, 1952, midway in the Korean War, and before that year was out, millions of pounds of Palmoshield had displaced imported palm oil for tin plate rolling in American and Canadian mills. Its use invariably proved so satisfactory that this volume has since doubled and tripled. Not only has Palmoshield made its place in tin plate rolling but in sheet rolling, long terne and coating lines as well. Today, on its fourth anniversary, "Palmoshield" has won an honored place in the dictionary of steel.

Names of other Ironsides "Shield" lubricants have been highly regarded in the steel plants for many years. Ironsides "roll neck shield," formulated for continuous application by automatic pressure, is known as the lubricant that keeps roll necks at constant temperature. Ironsides "roller bearing shield," an extreme pressure lubricant noted for high load-carrying capacity, is approved by leading makers of bearings.

Just as special problems had to be overcome before mills could roll steel in a continuous strip, almost every plant has lubrication problems special to its operation. Ironsides engineers are "custom tailors" of lubrication who welcome such opportunities to be helpful. Direct your letter or telephone call to The Ironsides Company, Columbus 16, Ohio.

By the makers of Palmoshield
"the palm tree that grows in Ohio"


JOSEPH MARCULES.

(Continued from p. 217)
that provides continuous re-circulation of filtered oil to bearing surfaces of light, medium, and heavy-duty machinery. Consisting of liquid pump, tank, filter, heat exchanger, control valve, and required piping, the units are easily installed and have extensive application in many fields. (Bowser Technical Refrigeration Div., LE-12/3, Main St., Terryville, Conn.)

Cleanable, Micronic Filter. Newly designed, all-metal, edge-type liquid filter stops micronic particles and is cleanable without interrupting flow. This new filter, designated "Super Auto-Klean," has been designed specifically for lube, fuel, and hydraulic liquids on diesels, machine tools, and special machinery. (Catalog SAK-057, Cuno Engineering Corp., LE-12/3, 4612 S. Vine St., Meriden, Conn.)

Book Reviews

"ASTM Standards On Petroleum Products & Lubricants" (Compilation); American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1955; 984 pages, price $7.15 for cloth covers, $6.50 for paper covers.

This special compilation prepared by the American Society for Testing Materials Committee D-2 on Petroleum Products and Lubricants includes tentative and standard methods of test, specifications, definitions of terms, and classifications of petroleum products and lubricants; together with related information, including the Report of Committee D-2, and many proposed methods of test.

The compilation has been published annually since 1927. The November 1955 edition includes 159 standards, 41 of which are new or revised since the previous edition.

Included are two new Tentative Methods of Test for Lubricating Qualities of Graphites (D 1367) and Trace Concentrations of Tetraethyllead in Primary Reference Fuels (D 1368). New standard Methods of Test are included for Aromatic Hydrocarbons in Olefin-Free Gasolines (D 936, Oxygen in Butadiene Vapors (D 1021), Effect of Grease on Copper (D 1261), Lead in New and Used Greases (D 1262), Sampling Liquified Petroleum Gases (D 1265), Unsaturated Light Hydrocarbons (D 1268), and several others.

This compilation is a valuable aid to chemists and technologists in the petroleum industry. It is also useful for purchasing agents, scientists, and engineers in the automotive, aircraft, railway, and other industries.

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(Lube in the News, from p. 166)

ment. Tuition is $200, due and payable upon notification of admission. Academic credit is not offered. The staff includes: M. C. Shaw, B. G. Rightmire, P. A. Smith, N. H. Cook, E. Rabinowicz, and G. S. Reichenbach.

Lectures to be presented from 9:30 a.m. to noon will include: (1) the structure and properties of solids and lubricants; (2) the nature of friction between dry and lubricated surfaces; (3) fundamentals of wear and transfer between surfaces in contact; (4) thermal considerations for sliding contacts; (5) techniques for use in wear studies; (6) wear studies involving radioactive tracer methods; (7) fretting corrosion; (8) mechanical erosion; (9) cavitation; (10) corrosive wear; (11) friction and wear in bearings; (12) the nature of tool wear; (13) temperatures and wear characteristics of cutting tools and grinding wheels; (14) machinability and machining economies; and (15) the statistical interpretation of friction and cutting data.

During the afternoon sessions, from 2:00 to 5:00, subgroups will be formed to work on special laboratory problems. Several problems of both the fundamental and applied types will be available for study. Insofar as possible, the participants will be given their choice of these problems for detailed study. All laboratory exercises will be designed to illustrate important concepts and general rules, and will be organized to enable the participants to become familiar with a variety of laboratory techniques and apparatus.

New Subsidiary for Commercial Filters Corporation. Commercial Filters Corporation of Melrose, Mass., has announced the merger of two famous filter lines, Honan-Crane and Michiana, to form a new subsidiary: Indiana Commercial Filters Corporation, following the Massachusetts firm's recent purchase of Houdaille-Hershey of Indiana, Inc. (makers of Honan-Crane filters) and the Filter Division of Michiana Products Corp. Honan-Crane and Michiana manufacturing, research, and engineering facilities will be consolidated at Lebanon, Ind. The Honan-Crane and Michiana filter lines will be retained under their present names, while a new brand name, "CFC," will identify filtering and conveying equipment formerly known as "Houdaille." The parent company will continue to manufacture Commercial Fulflo Filters and Honeycomb Filter Tubes at its modern Melrose plant.

Conference on Lubrication & Wear. The Council of the Institution of Mechanical Engineers is arranging a "Conference on Lubrication & Wear" to be held in London, October 1-3, 1957. It will be international in scope, as papers are being sought from the United States, Canada, and most European countries, as well as from the United Kingdom. ASME has been asked to co-operate in this effort by obtaining suitable papers from American and Canadian authors.

It is intended that the published proceedings of the Conference will constitute a useful reference work covering the whole field of lubrication and wear. Hence, it is planned to have papers that collate and summarize well-established aspects of the subject and, where possible, enlarge on them; and other papers devoted to topics that are rapidly developing.

The preliminary program includes sessions devoted to the following subjects: (1) limitations of the theoretical treatment of fluid film lubrication and the relationship with experimental results; (2) evaluation of present knowledge in regard to fluctuating loads and bearing oscillations; (3) thin films and elasto-hydrodynamic lubrication; (4) physics and physical chemistry of solid friction and boundary lubrication; (5) wear, including fretting corrosion, the running in of mechanisms, wear due to abrasion and foreign particles, influence of

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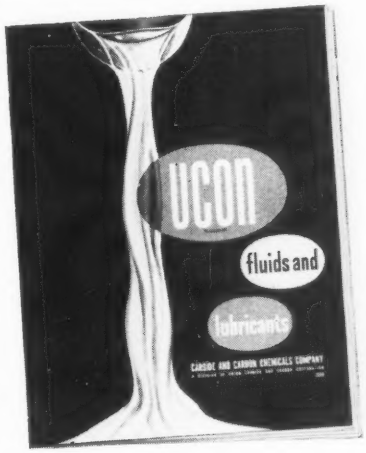

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lubricants, scuffing, major surface changes, influence and nature of rubbing surfaces, technique of wear investigation; (6) bearing metals and other bearing materials, lubrication of glands and seals, solid lubricants and surface treatments; (7) anti-friction bearing and gear lubrication; (8) additives for lubricants, fluids for metal cutting and forming; and (9) special problems in connection with atomic energy.

Authors are asked to submit first a brief synopsis, of approximately 200 words, by September 1, 1956, setting forth the proposed title and contents of their contribution. This should be sent to Mr. C. C. Moore, General Engineering Laboratory, General Electric Co., Schenectady 5, N. Y. January 1, 1957, is the deadline set for submitting completed papers. (It is expected that some of the papers by U. S. and Canadian authors will be selected for presentation at the ASLE-ASME Lubrication Conference, October 1957, at Toronto, Canada.)

(Lube Lines, continued from p. 173)

Temperature Control Important. Another probability which must be considered by the designer is high temperature. Machine parts do not necessarily have to run exposed to high temperature surroundings, as in steel rolling, to involve abnormal temperatures at bearing or gear tooth surfaces. Friction at these surfaces will promote increase in temperature. It must be anticipated when the type of bearing or gear is being decided upon, and when the lubricating system is considered. If either are inadequate as far as temperature control is concerned, even an excess of lubrication cannot be expected to keep the temperatures within safe limits. Then, metallurgical changes may develop in the form of reduced hardness of steel shafting or gear teeth. The American Gear Manufacturers Association, in their publication concerning gear tooth wear and failure (Standard No. 110.02, issued Dec. 1941), points out what can happen to gear teeth.

Heat transfer is an important function of lubrication. This does not necessarily mean, however, that heat transfer equipment must be included in the design when the installation is being planned. Splash- or drip-lubricated enclosed chain drives, worm gears, and unit-lubricated ball and roller bearings are typical examples of where heat absorbed by the lubricant is transmitted to the case and removed from the exterior by contact with air. Adequate radiation plays an important part in temperature control of such mechanisms; unfortunately, the designer cannot always plan for ventilation and radiation. The location of the installation may enter into the picture.

When this possibility becomes apparent to the designer, he is justified in considering the idea of including means for auxiliary temperature control by water-cooling equipment or possibly oil-cooling. Normally, water-cooling is the most practicable where there is an adequate supply of water available, and where the cost of pumping and piping does not become exorbitant as compared with the value of the installation.

Water-cooling is accomplished by: (a) jacketing the case, for example the crankcase of an automotive engine; or (b) by locating cooling coils in the oil reservoir. In reality, the latter functions as a built-in heat exchanger; by varying the rate of water flow, better control of heat transfer is realized than can be obtained from a crankcase cooling system where flow of air through the radiator is relied upon to bring down the temperature of the cooling water in the system.

The designer should be conversant with the rate of heat transfer which is to be maintained in service. Control of lubricating oil inlet and outlet temperatures must be practicable in steel mill oil-film roll-neck bearing circulating systems, and in paper machine dryer roller bearings. In steel mill service the circulating oil temperature is held between a range of 90 and 120 F. The lubricating oil temperature range in a paper machine circulating system is generally kept between around 135 F. inlet and 175 F. outlet. An oil flow of around 3 pints per minute through the drive-side roller bearings enables adequate control of the bearing temperatures. Obviously, the means the plant provides for cooling water is another factor which must be known to the designer.

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Did you know Illinois Law specifically mentions 30 days as the dividing line between a temporary and a permanent position, but we use a 90 day period in E.S.P.S.?

ENGINEERS AVAILABLE

(489-LE) CHEM. ENGR.—METAL WORKING LUBRICANTS: 53, BS in Ch.E. & 2 yrs. grad. study: 25 yrs. continued exper. in devel., mfr. and control of such lubricants in Midwest & on the West Coast. $6000. Desire SF Peninsula.

(490-LE) PHYSICIST: 40, BA; 10 yrs. var. elect., electronic & mech. instrum. NW or Midwest.

(491-LE) CHEM: 31, BS; 3 yrs. control lab. superv. 2 yrs. analysis & devel. also 1 yr. journ. exp. Chicago, West, Southwest.

POSITIONS AVAILABLE

F-3163 LUBR. ENGRS. (2) 1 Eng. speak. & 1 French speak. up to 35, ME deg. for major oil co.; must have had exp. in lubr. & petrol. prod. sal. commensurate with exp. loc. West Africa.

C-4235 ENGR. EE or ME; age 25-35; 3 yrs. exp. wire & cable; know plastic extrusion; duties: tech. dir. of wire mfgr. dept. of med. sized firm; present oper. consist of wire twisting thermoplastic insulating, braiding, etc. expansion into spec. field under way & demands aggressive devel. work; sal. $5500-7200/yr. loc: Chgo. till spring, then Cent. Ky. empl. will neg. fee.

C-4754 LUBR. ENG. ME age: 32-38, 3 plus yrs. exp. with machinery & machine shop oper; duties: acting as consult. to sales dept. on indus. lubr. problems; will also advise industrials in gen'l. on lubr. systems & products; some trav. car req'd. for refiner of petr. sal: $650/mo. loc: Chicago, emp. will pay fee.

C-4755 SALES—LUBR. Degree, age to 32; duties: training for indust. sales of lubr. & other petroleum products; some trav. car req'd. for refiner of oil; sal: $475-525/mo. loc. Chicago, emp. will neg. fee.

C-4774 SALES—PACKINGS. ME or Ch.E. age to 32; 1 plus yrs. exp. in indust. sales of mech. rubber, gaskets or similar products; duties: selling teflon, rubber & asbestos packings to indust. & O.E.M's. car req'd for mfr. of packings sal. $450-500/mo. loc. Chicago, empl. will neg. fee.

C-4797 SALES—INDUS. ROLLS. Age to 45; know. ind. rolls, rubber; duties: charge of indust. roll div. rubber, sales over nat. organization; trav. car furn. for mfr. of rubber rolls; sal. $10-12,000 loc: Chicago; emp. will pay fee.

C-4805 MAT'L ENGR.—RUBBER & PLASTICS. Chem. or Ch.E. 4 plus yrs. in lab. or devel. in rubber or synthetics; know. design of small parts & qual. control; duties: supv. mat'ls. control lab. on rubber, synthetics & plastics; for mfg. valves; sal. $6-700/mo. loc. Chicago; emp. will pay fee.

C-4808 CHEM. SALES — LUBR. Chem. or Ch.E. age to 45; 3 plus yrs. in selling lubrs. to steel rolling mills; know lubr. duties: selling line of lubr. cutting oils & allied prod. to rolling mill & other indust. car supplied, for Mfr. of oils; sal. $7-10,000 loc. Chicago, emp. will neg. fee.

C-4856 SR. RES. PHYSICIST. Physics Div. PhD. in physics; age 30-45; 10 yrs. exp. res. & dev. in physics, as geophysics, radiation, electro-magnetic meteorology, acoustics, etc. know applied res. tech. in physics; duties: in physics div. for planning, supv. & tech. res. engrs. conduct. applied physics res. projects; encourage to teach part time at grad. or under-grad. level & to dev. ideas for sponsorship; limited trav., for Res. Inst. sal. $625-850; loc. Colo. emp. will neg. fee.

C-4863 PROJECT ENG. ME or Ch.E. 3 plus yrs. in design of process plants or process eqpt. duties: project work in pilot plant, process dev. or/& design of process eqpt. some trav. for distillers of coal tar; sal. to $8000/yr. loc. Pa. emp. will pay fee.

C-4877 CHEMISTS OR CH.E. Chem./Ch.E. age to 35; 2 plus yrs. in organic res. or dev. know petr. tech. or fluidized solids systems; duties: process dev. work in organic, fluidized solids systems; for mfr. of steel; sal. to $900/mo. loc. Pa.

C-4882 PROCESS ENGR.—CHEM. Ch.E. age 30-40, 3 plus yrs. in process des. or dev. of process plant oper. know fluid flow & thermo-dynamics; duties: dev. processes & eqpt. for physical separation of complex mixtures of low molecular weight gases & liquids; for mfr. of gas eqpt. sal. to $12,000. loc. Pa.

C-4883 ESTIMATOR. ME or Ch.E. age 35-40, 3 plus yrs. in est. cost of process plants eqpt. & weldments; duties: est. costs of process plants, eqpt. weldments plate & angle structure, pressure vessels, heat exchangers & mach. assemblies; for mfr. of gas eqpt. sal. to $10,000. loc. Pa.

C-4885 METALLURGICAL APPL. ENGR. ME, Met. or Ch.E. age to 40; 5 plus yrs. in appl. & usage of indus. gases, used in iron & steel ind. duties: consultant to sales & customers on the appl. & uses of oxygen, nitrogen, argon, helium, acetylene & other gases for the steel & metallurgical ind. for mfr. of gas eqpt. sal. to $9000. loc. Pa.

C-4886 PROCESS PLANT INSTRU. ENGR. Ch. or ME. age to 50; 5 plus yrs. in process plant instrumentation; duties: supv. selection & layout of instrumentation of process plants ranging from small to multi-million dollar low temp. gas oper. systems; for mfr. of gas eqpt. sal. to $12,000. loc. Pa.

C-4887 ERECTION ENGR. ME or Ch.E. age to 50; 3 plus yrs. in field supv. erection of processing plants & eqpt. duties: supv. erection of chem. or petrol. plants, machy. & apparatus; a great deal of trav. for mfr. of gas eqpt. sal. to $10,000. loc. Pa. hdqtr.

C-4889 DEV. & TEST ENGRS. Ch.E. or ME. age to 50; 1 plus yrs. in test or dev. projects for process plants & eqpt. duties: testing or dev. work on oxygen generators, heat exchangers, pressure vessels, piping, valves controls, instrumentation & sim. eqpt. for indus. gas & other process plants; for mfr. of gas eqpt. sal. to $12,000. loc. Pa.

C-4900 SALES MKT. RES.—BR. MGRS. Ch.E. or ME. age to 40; 3 plus yrs. in sales or mkt. res. work on indust. gas eqpt. & allied prod. duties: sales or mkt. res. on oxygen generating systems & other low temp. gases sold to process ind. & metal working plants; some inside positions in Pa. for mfr. of gas eqpt. sal. to $10,000 plus profit sharing; loc. Pa., Mo., Ill.

C-4911 APPL. ENGR. Degree, age to 35; know refr. chem. welding or foundry oper. duties: assist salesmen & customers on solving tech. problems with respect to appl. of carbon dioxide; some trav. for mfr. of ind. gas. sal. $6-7200. loc. Ohio & Pa. emp. will pay fee.

C-4931 RES. DIRECTOR. Malt MS or better in Chem. age to 45; 5 plus yrs. supv. research in foods, biologicals, pharmaceuticals or similar fields; know basic research duties: direct. & recommend programs in research in malt prod. will supv. lab. & pilot plants; for mfr. of malt. sal. to $15,000. loc. Wis. emp. will pay fee.

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Alemite Div., Stewart-Warner Corp. 162
Alpha Molykote Corp., The 172
American Potash & Chemical Corp. 215
Atlantic Refining Co., The 164
Baroid Div., National Lead Co. ..... 212 & 216
Bel-Ray Co., Inc. 167
Brooks Oil Co., The 176
Burns Laboratories, Inc. 211
Carbide & Carbon Chemicals Co. 221
Climax Molybdenum Co. ..... 180 & 181
Commercial Research Laboratories, Inc. 224
Cuno Engineering Corp. 175
Farval Corp., The ..... (Inside Back Cover)
Grafo Colloids Corp. 222
Hodson Corp., The ..... (Back Cover)
Houghton & Co., E. F. 168
International Lubricant Corp. 209
Ironsides Co., The ..... 218 & 219
Lincoln Engineering Co. 220
Madison-Kipp Corp. 182
Manzel Div. of Houdaille Industries, Inc. 217
Morgan Construction Co. 210
Norgren Co., C. A. 213
Shell Oil Co. 171
Sinclair Refining Co. 214
Sun Oil Co. 163
Trabon Engineering Corp. ..... (Inside Front Cover)
Wiley & Sons, Inc., John 208

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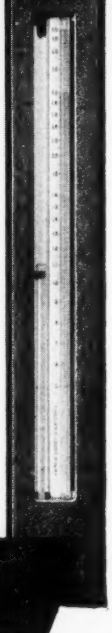

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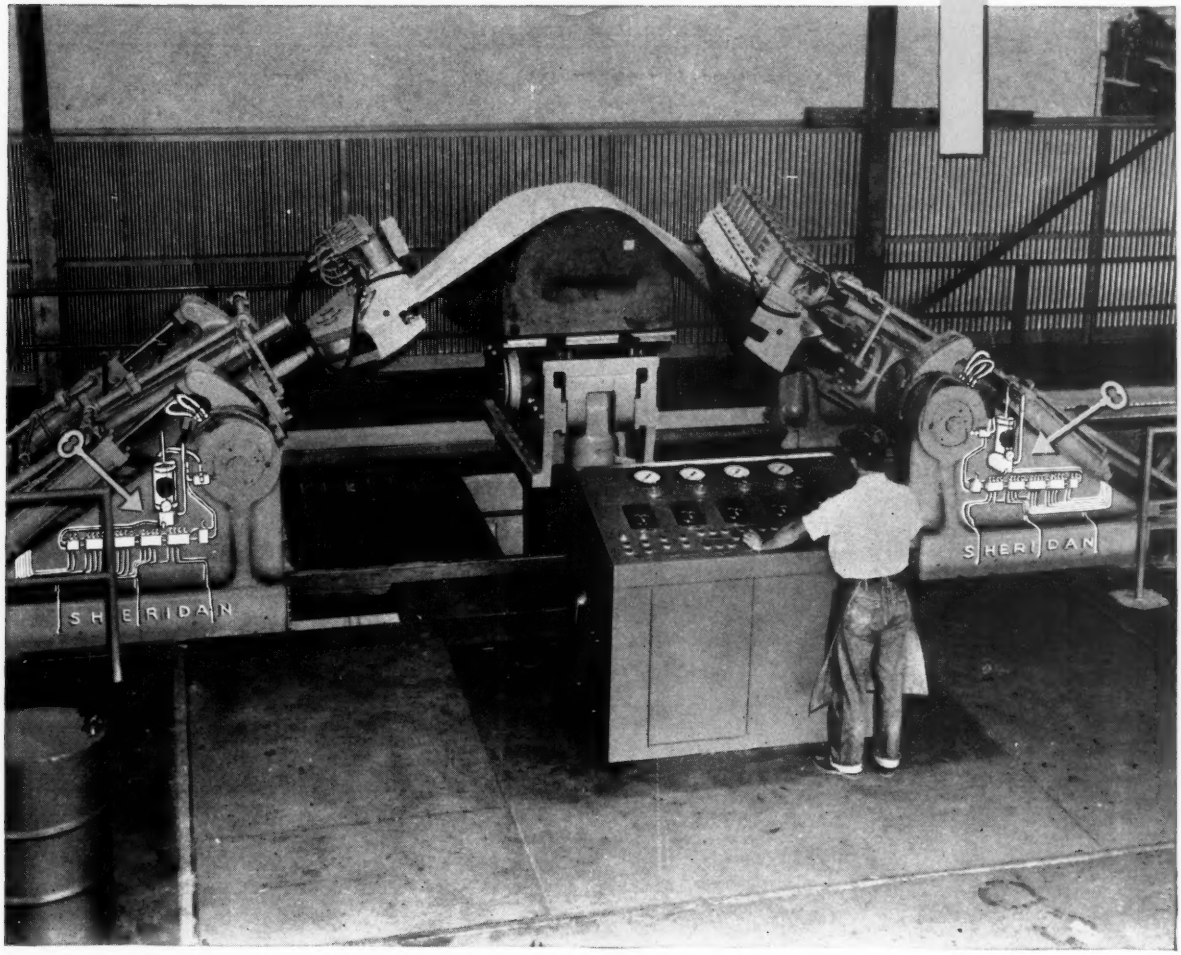

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